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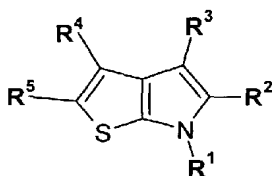
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(54) Title: **CHEMICAL COMPOUNDS**



(I)

(57) Abstract: The invention relates to a group of novel thieno-pyrrole compounds of Formula (I) wherein: R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup> and R<sup>5</sup> are as defined in the specification, which compounds are useful as gonadotrophin releasing hormone antagonists. The invention also relates to pharmaceutical formulations of said compounds, methods of treatment using said compounds and to processes for the preparation of said compounds.

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## DERIVATIVES OF THIENOPYRROLE AS GNRH ANTAGONISTS

The present invention relates to compounds which are antagonists of gonadotropin releasing hormone (GnRH) activity. The invention also relates to pharmaceutical formulations, the use of a compound of the present invention in the manufacture of a medicament, a method of therapeutic treatment using such a compound and processes for producing the compounds.

Gonadotropin releasing hormone (GnRH) is a decapeptide that is secreted by the hypothalamus into the hypophyseal portal circulation in response to neural and/or chemical stimuli, causing the biosynthesis and release of luteinizing hormone (LH) and follicle-stimulating hormone (FSH) by the pituitary. GnRH is also known by other names, including gonadoliberin, LH releasing hormone (LHRH), FSH releasing hormone (FSH RH) and LH/FSH releasing factor (LH/FSH RF).

GnRH plays an important role in regulating the action of LH and FSH (by regulation of their levels), and thus has a role in regulating the levels of gonadal steroids in both sexes, including the sex hormones progesterone, oestrogens and androgens. More discussion of GnRH can be found in WO 98/55119 and WO 97/14697, the disclosures of which are incorporated herein by reference.

It is believed that several diseases would benefit from the regulation of GnRH activity, in particular by antagonising such activity. These include sex hormone related conditions such as sex hormone dependent cancer, benign prostatic hypertrophy and myoma of the uterus. Examples of sex hormone dependent cancers are prostatic cancer, uterine cancer, breast cancer and pituitary gonadotrophe adenoma.

The following disclose compounds purported to act as GnRH antagonists:

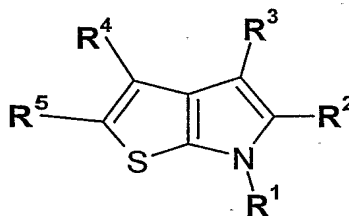
WO 97/21435, WO 97/21703, WO 97/21704, WO 97/21707, WO 55116, WO 98/55119, WO 98/55123, WO 98/55470, WO 98/55479, WO 99/21553, WO 99/21557, WO 99/41251, WO 99/41252, WO 00/04013, WO 00/69433, WO 99/51231, WO 99/51232, WO 99/51233, WO 99/51234, WO 99/51595, WO 99/51596, WO 00/53178, WO 00/53180, WO 00/53179, WO 00/53181, WO 00/53185, WO 00/53602, WO 02/066477, WO 02/066478, WO 02/06645 and WO 02/092565.

In addition, co-pending WO2004/018480 and WO2004/018479, which were unpublished at the date of the present application, describe a range of thienopyrrole derivatives that have this activity.

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It would be desirable to provide further compounds, such compounds being GnRH antagonists. The applicants have found that certain selected compounds within the scope of WO2004/018480 show this activity, and can also demonstrate improved physicochemical properties, such as bioavailability, solubility and/or protein binding.

5 Thus, according to the first aspect of the invention there is provided a compound of Formula (I),



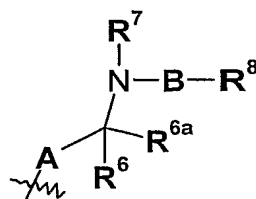
Formula (I)

10 wherein:

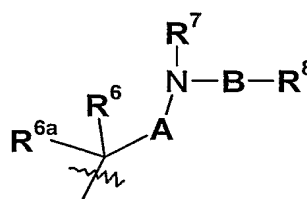
**R¹** is selected from: hydrogen, optionally substituted C<sub>1-6</sub>alkyl, optionally substituted aryl or optionally substituted arylC<sub>1-6</sub>alkyl, wherein the optional substituents are selected from C<sub>1-4</sub>alkyl, C<sub>1-4</sub>alkoxy, nitro, cyano and fluoro;

**R²** is hydrogen, optionally substituted C<sub>1-6</sub>alkyl or an optionally substituted mono or  
 15 bi-cyclic aromatic ring, wherein the optional substituents are 1, 2 or 3 substituents independently selected from: cyano, **R<sup>e</sup>R<sup>f</sup>N-**, C<sub>1-6</sub>alkyl, C<sub>1-6</sub>alkoxy, halo, haloC<sub>1-6</sub>alkyl or haloC<sub>1-6</sub>alkoxy wherein **R<sup>e</sup>** and **R<sup>f</sup>** are independently selected from hydrogen, C<sub>1-6</sub>alkyl or aryl;

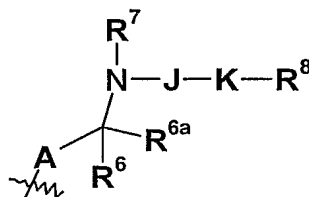
**R³** is selected from a group of Formula (IIa) to Formula (IId):



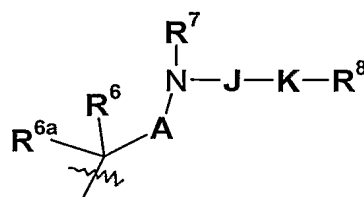
Formula (IIa)



Formula (IIb)



Formula (IIc)



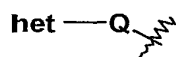
Formula (IId)

20

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$R^4$  is selected from hydrogen,  $C_{1-4}$ alkyl or halo;

$R^5$  is a group of the formula



wherein:

5 **het** represents a heteroaryl ring, optionally substituted by from 1 to 2 groups selected from  $R^{12}$  and  $R^{13}$ ; and

**Q** is selected from a direct bond or  $-[C(R^{15}R^{15a})]_{1-2}$ -

each  $R^{15}$  and  $R^{15a}$  are independently selected from:

- 10 (i) hydrogen or optionally substituted  $C_{1-8}$ alkyl, wherein the optional substituents are selected from  $R^{12}$ ; or
- (ii)  $R^{15}$  and  $R^{15a}$  together with the carbon to which they are attached form an optionally substituted 3 to 7-membered cycloalkyl ring, wherein the optional substituents are selected from  $R^{12}$ ;

15  $R^6$  and  $R^{6a}$  are independently selected from hydrogen, fluoro, optionally substituted  $C_{1-6}$ alkyl,  $C_{1-6}$ alkoxy, N- $C_{1-6}$ alkylamino and N,N-di $C_{1-6}$ alkylamino or  $R^6$  and  $R^{6a}$  taken together and the carbon atom to which they are attached form a carbocyclic ring of 3-7 atoms or  $R^6$  and  $R^{6a}$  taken together and the carbon atom to which they are attached form a carbonyl group;

20 or when **A** is not a direct bond the group forms a carbocyclic ring of 3-7 carbon atoms or a heterocyclic ring containing one or more heteroatoms;

or the group forms a heterocyclic ring containing 3-7 carbon atoms and one or more heteroatoms;

$R^7$  is selected from: hydrogen or  $C_{1-6}$ alkyl;

$R^8$  is selected from:

- 25 (i) hydrogen,  $C_{1-6}$ alkyl,  $C_{2-6}$ alkenyl,  $C_{2-6}$ alkynyl, halo $C_{1-6}$ alkyl,  $C_{1-4}$ alkoxy $C_{1-4}$ alkyl, hydroxy, hydroxy $C_{1-6}$ alkyl, cyano, N- $C_{1-4}$ alkylamino, N,N-di- $C_{1-4}$ alkylamino,  $C_{1-6}$ alkyl-S( $O_n$ )-, -O- $R^b$ , -NR<sup>b</sup>R<sup>c</sup>, -C(O)- $R^b$ , -C(O)O- $R^b$ , -CONR<sup>b</sup>R<sup>c</sup>,

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NH-C(O)-R<sup>b</sup> or -S(O)<sub>n</sub>NR<sup>b</sup>R<sup>c</sup>,

where R<sup>b</sup> and R<sup>c</sup> are independently selected from hydrogen and C<sub>1-6</sub>alkyl (e.g. C<sub>1-4</sub>alkyl) optionally substituted with hydroxy, amino, N-C<sub>1-4</sub>alkylamino, N,N-di-C<sub>1-4</sub>alkylamino, HO-C<sub>2-4</sub>alkyl-NH- or HO-C<sub>2-4</sub>alkyl-N(C<sub>1-4</sub>alkyl)-;

- 5 (ii) nitro when B is a group of Formula (IV) and X is CH and p is 0;
- (iii) carbocyclyl (such as C<sub>3-7</sub>cycloalkyl or aryl) or arylC<sub>1-6</sub>alkyl each of which is optionally substituted by R<sup>12</sup> or R<sup>13</sup>;
- (iv) heterocyclyl or heterocyclylC<sub>1-6</sub>alkyl each of which is optionally substituted by up to 4 substituents independently selected from R<sup>12</sup> or R<sup>13</sup> and where any nitrogen
- 10 atoms within a heterocyclyl group are, where chemically allowed, optionally in their oxidised (N→O, N-OH) state;

R<sup>12</sup> is independently selected from: halo, hydroxy, hydroxyC<sub>1-6</sub>alkyl, oxo, cyano, cyanoC<sub>1-6</sub>alkyl, nitro, carboxyl, C<sub>1-6</sub>alkyl, C<sub>1-6</sub>alkoxy, C<sub>1-6</sub>alkoxyC<sub>1-4</sub>alkyl, C<sub>1-6</sub>alkoxycarbonylC<sub>0-4</sub>alkyl, C<sub>1-6</sub>alkanoylC<sub>0-4</sub>alkyl, C<sub>1-6</sub>alkanoyloxyC<sub>0-4</sub>alkyl, C<sub>2-6</sub>alkenyl, C<sub>1-3</sub>perfluoroalkyl-, C<sub>1-3</sub>perfluoroalkoxy, aryl, arylC<sub>1-6</sub>alkyl, heterocyclyl, heterocyclylC<sub>1-6</sub>alkyl, aminoC<sub>0-4</sub>alkyl, N-C<sub>1-4</sub>alkylaminoC<sub>0-4</sub>alkyl, N, N-di-C<sub>1-4</sub>alkylaminoC<sub>0-4</sub>alkyl, carbamoyl, N-C<sub>1-4</sub>alkylcarbamoylC<sub>0-2</sub>alkyl, N, N-di-C<sub>1-4</sub>alkylaminocarbamoylC<sub>0-2</sub>alkyl, aminocarbonylC<sub>0-4</sub>alkyl, N-C<sub>1-6</sub>alkylaminocarbonylC<sub>1-4</sub>alkyl, N, N-C<sub>1-6</sub>alkylaminocarbonylC<sub>0-4</sub>alkyl, C<sub>1-6</sub>alkyl-S(O)<sub>n</sub>-aminoC<sub>0-4</sub>alkyl-, aryl-S(O)<sub>n</sub>-aminoC<sub>0-2</sub>alkyl-, C<sub>1-3</sub>perfluoroalkyl-S(O)<sub>n</sub>-aminoC<sub>0-2</sub>alkyl-, C<sub>1-6</sub>alkylamino-S(O)<sub>n</sub>-C<sub>0-2</sub>alkyl-, arylamino-S(O)<sub>n</sub>-C<sub>0-2</sub>alkyl-, C<sub>1-3</sub>perfluoroalkylamino-S(O)<sub>n</sub>-C<sub>0-2</sub>alkyl-, C<sub>1-6</sub>alkanoylamino-S(O)<sub>n</sub>-C<sub>0-2</sub>alkyl-, arylcarbonylamino-S(O)<sub>n</sub>-C<sub>0-2</sub>alkyl-, C<sub>1-6</sub>alkyl-S(O)<sub>n</sub>-C<sub>0-2</sub>alkyl-, aryl-S(O)<sub>n</sub>-C<sub>0-2</sub>alkyl-, C<sub>1-3</sub>perfluoroalkyl-, C<sub>1-3</sub>perfluoroalkoxyC<sub>0-2</sub>alkyl; R<sup>9'</sup>OC(O)(CH<sub>2</sub>)<sub>w</sub>-, R<sup>9''</sup>R<sup>10''</sup>N(CH<sub>2</sub>)<sub>w</sub>-, R<sup>9'</sup>R<sup>10'</sup>NC(O)(CH<sub>2</sub>)<sub>w</sub>-, R<sup>9</sup>R<sup>10</sup>NC(O)N(R<sup>9</sup>)(CH<sub>2</sub>)<sub>w</sub>-, R<sup>9</sup>OC(O)N(R<sup>9</sup>)(CH<sub>2</sub>)<sub>w</sub>-, or halo, wherein w is an integer between 0 and 4 and R<sup>9</sup> and R<sup>10</sup> are independently selected from hydrogen, C<sub>1-4</sub>alkyl, C<sub>1-4</sub>alkylsulphonyl and C<sub>3-7</sub>carbocyclyl, R<sup>9'</sup> and R<sup>10'</sup> are independently selected from C<sub>1-4</sub>alkylsulphonyl and C<sub>3-7</sub>carbocyclyl, and R<sup>9''</sup> and R<sup>10''</sup> are C<sub>3-7</sub>carbocyclyl; wherein an amino or an aryl group within R<sup>12</sup> is optionally

20 substituted by C<sub>1-4</sub>alkyl;

25

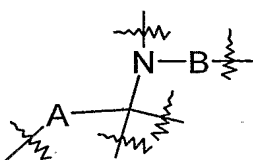
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$R^{13}$  is  $C_{1-4}$ alkylaminocarbonyl optionally substituted by 1, 2 or 3 groups selected from  $R^{12}$ , or  $R^{13}$  is a group  $-C(O)-R^{16}$  where  $R^{16}$  is selected from an amino acid derivative or an amide of an amino acid derivative;

A is selected from:

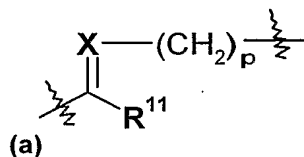
- 5 (i) a direct bond;
- (ii) optionally substituted  $C_{1-5}$ alkylene wherein the optional substituents are independently selected from: hydroxy, hydroxy $C_{1-6}$ alkyl,  $C_{1-6}$ alkyl,  $C_{1-6}$ alkoxy,  $C_{1-4}$ alkoxy $C_{1-4}$ alkyl, aryl or aryl $C_{1-6}$ alkyl;
- (iii) a carbocyclic ring of 3-7 atoms;
- 10 (iv) a carbonyl group or  $-C(O)-C(R^d R^d)-$ , wherein  $R^d$  is independently selected from hydrogen and  $C_{1-2}$ alkyl;

or when  $R^3$  is a group of Formula (IIa) or (IIb), the group  forms a heterocyclic ring containing 3-7 carbon atoms and one or more heteroatoms;

or when  $R^3$  is a group of Formula (IIa), (IIb), (IIc) or (IId), the group  forms a heterocyclic ring containing 3-7 carbon atoms and one or more heteroatoms;

B is selected from:

- (i) a direct bond;
- (ii) a group of Formula (IV)



Formula (IV)

wherein:

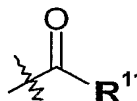
X is selected from N or CH,

wherein at position (a) Formula (IV) is attached to the nitrogen atom and the  $(CH_2)_p$  group is attached to  $R^8$ ; and

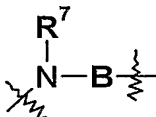
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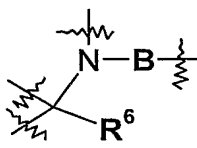
(iii) a group independently selected from: optionally substituted C<sub>1-6</sub>alkylene, optionally substituted C<sub>3-7</sub>cycloalkyl, optionally substituted C<sub>3-6</sub>alkenylene, optionally substituted C<sub>3-6</sub>alkynyl, (C<sub>1-5</sub>alkyl)<sub>aa</sub>-S(O<sub>n</sub>)-(C<sub>1-5</sub>alkyl)<sub>bb</sub>-, -(C<sub>1-5</sub>alkyl)<sub>aa</sub>-O-(C<sub>1-5</sub>alkyl)<sub>bb</sub>-, -(C<sub>1-5</sub>alkyl)<sub>aa</sub>-C(O)-(C<sub>1-5</sub>alkyl)<sub>bb</sub>- or (C<sub>1-5</sub>alkyl)<sub>aa</sub>-N(R<sup>14</sup>)-(C<sub>1-5</sub>alkyl)<sub>bb</sub>, or (C<sub>1-5</sub>alkyl)<sub>aa</sub>-C(O)N(R<sup>14</sup>)-(C<sub>1-5</sub>alkyl)<sub>bb</sub>, wherein R<sup>14</sup> is hydrogen or C<sub>1-4</sub>alkyl, or R<sup>14</sup> and the (C<sub>1-5</sub>alkyl)<sub>aa</sub> or (C<sub>1-5</sub>alkyl)<sub>bb</sub> chain can be joined to form a heterocyclic ring, wherein aa and bb are independently 0 or 1, and the combined length of (C<sub>1-5</sub>alkyl)<sub>aa</sub> and (C<sub>1-5</sub>alkyl)<sub>bb</sub> is less than or equal to C<sub>5</sub>alkyl and wherein the optional substituents are independently selected from R<sup>12</sup>;

or the group -B-R<sup>8</sup> represents a group of Formula (V)



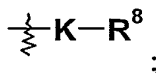
Formula (V);

or the group  together forms an optionally substituted heterocyclic ring containing 4-7 carbons atoms, wherein the optional substituents are selected from 1 or 2 substituents independently selected from R<sup>12</sup> and R<sup>13</sup>;

or the group  forms a heterocyclic ring containing 3-7 carbon atoms and one or more heteroatoms;

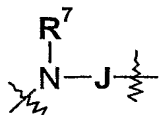
R<sup>11</sup> is selected from: hydrogen, optionally substituted C<sub>1-6</sub>alkyl or N(R<sup>23</sup>R<sup>24</sup>);

R<sup>23</sup> and R<sup>24</sup> are independently selected from: hydrogen, hydroxy, optionally substituted C<sub>1-6</sub>alkyl, optionally substituted aryl, optionally substituted arylC<sub>1-6</sub>alkyl, an optionally substituted carbocyclic ring of 3-7 atoms, optionally substituted heterocyclyl, optionally substituted heterocyclylC<sub>1-6</sub>alkyl or R<sup>23</sup> and R<sup>24</sup> taken together can form an optionally substituted ring of 3-9 atoms, wherein the optional substituents are selected from R<sup>12</sup> and



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**J** is a group of the formula:  $-(CH_2)_s-L-(CH_2)_s-$  or  $-(CH_2)_s-C(O)-(CH_2)_s-L-(CH_2)_s-$  wherein when *s* is greater than 0, the alkylene group is optionally substituted by 1 or 2 groups selected from **R**<sup>12</sup>,



or the group together forms an optionally substituted heterocyclic ring

5 containing 4-7 carbons atoms, wherein the optional substituents are selected from 1 or 2 substituents independently selected from **R**<sup>12</sup> and **R**<sup>13</sup>;

**K** is selected from: a direct bond,  $-(CR^{21}R^{22})_{s1}-$ ,  $-(CR^{21}R^{22})_{s1}-O-(CR^{21}R^{22})_{s2}-$ ,

$-(CR^{21}R^{22})_{s1}-C(O)-(CR^{21}R^{22})_{s2}-$ ,  $-(CR^{21}R^{22})_{s1}-S(O)_n-(CR^{21}R^{22})_{s2}-$ ,

$-(CR^{21}R^{22})_{s1}-N(R^{14a})-(CR^{21}R^{22})_{s2}-$ ,  $-(CR^{21}R^{22})_{s1}-C(O)N(R^{14a})-(CR^{21}R^{22})_{s2}-$ ,

10  $-(CR^{21}R^{22})_{s1}-N(R^{14a})C(O)-(CR^{21}R^{22})_{s2}-$ ,  $-(CR^{21}R^{22})_{s1}-N(R^{14a})C(O)N(R^{14a})-(CR^{21}R^{22})_{s2}-$ ,

$-(CR^{21}R^{22})_{s1}-OC(O)-(CR^{21}R^{22})_{s2}-$ ,  $-(CR^{21}R^{22})_{s1}-C(O)O-(CR^{21}R^{22})_{s2}-$ ,

$-(CR^{21}R^{22})_{s1}-N(R^{14a})C(O)O-(CR^{21}R^{22})_{s2}-$ ,  $-(CR^{21}R^{22})_{s1}-OC(O)N(R^{14a})-(CR^{21}R^{22})_{s2}-$ ,

$-(CR^{21}R^{22})_{s1}-OS(O)_n-(CR^{21}R^{22})_{s2}$ , or  $-(CR^{21}R^{22})_{s1}-S(O)_n-O-(CR^{21}R^{22})_{s2}-$ ,

$-(CR^{21}R^{22})_{s1}-S(O)_2N(R^{14a})-(CR^{21}R^{22})_{s2}$  or  $-(CR^{21}R^{22})_{s1}-N(R^{14a})S(O)_2-(CR^{21}R^{22})_{s2}-$ ;

15 wherein **R**<sup>14a</sup> is hydrogen or C<sub>1-4</sub>alkyl, each **R**<sup>21</sup> and **R**<sup>22</sup> group is independently selected from hydrogen, hydroxy or optionally substituted C<sub>1-4</sub>alkyl, wherein the optional substituent is a group **ZR**<sup>30</sup> where **Z** is oxygen or a group **S(O)<sub>n</sub>**, and **R**<sup>30</sup> is hydrogen or C<sub>1-4</sub>alkyl;

**L** is selected from optionally substituted aryl or optionally substituted heterocyclyl;

20 **n** is an integer from 0 to 2;

**p** is an integer from 0 to 4;

**s**, **s1** and **s2** are independently selected from an integer from 0 to 4, and

**s1+s2** is less than or equal to 4;

or a salt, solvate or pro-drug thereof.

25 In a particular embodiment of the invention there is provided a compound of Formula (I) as defined above, which contains a group **R**<sup>13</sup> wherein:

**R**<sup>13</sup> is  $-C(O)-R^{16}$ ;

**R**<sup>16</sup> is selected from an amino acid derivative or an amide of an amino acid derivative; or a salt, solvate or pro-drug thereof.



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According to a further feature of the first aspect of the invention there is provided a pharmaceutical formulation comprising a compound of Formula (I), or salt, pro-drug or solvate thereof, and a pharmaceutically acceptable diluent or carrier.

According to a further feature of the first aspect of the invention there is provided the following uses of a compound of Formula (I), or salt, pro-drug or solvate thereof:

- (a) the use in the manufacture of a medicament for antagonising gonadotropin releasing hormone activity;
- (b) the use in the manufacture of a medicament for administration to a patient, for reducing the secretion of luteinizing hormone by the pituitary gland of the patient; and
- 10 (c) the use in the manufacture of a medicament for administration to a patient, for therapeutically treating and/or preventing a sex hormone related condition in the patient, preferably a sex hormone related condition selected from prostate cancer and pre-menopausal breast cancer.

According to a further aspect of the invention there is provided a method of  
15 antagonising gonadotropin releasing hormone activity in a patient, comprising administering a compound of Formula (I), or salt, pro-drug or solvate thereof, to a patient.

Whilst pharmaceutically-acceptable salts of compounds of the invention are preferred, other non-pharmaceutically-acceptable salts of compounds of the invention may also be useful, for example in the preparation of pharmaceutically-acceptable salts of compounds of  
20 the invention.

Whilst the invention comprises compounds of the invention, and salts, pro-drugs or solvates thereof, in a further embodiment of the invention, the invention comprises compounds of the invention and salts thereof.

In the present specification, unless otherwise indicated, an **alkyl**, **alkylene**, **alkenyl** or  
25 **alkynyl** moiety may be linear or branched. The term "**alkylene**" refers to the group  $-\text{CH}_2-$ . Thus,  $\text{C}_8$  alkylene for example is  $-(\text{CH}_2)_8-$ . For avoidance of doubt the term  $\text{C}_0$ alkyl within the group  $\text{C}_{0-5}$ alkyl is a direct bond.

The term '**propylene**' refers to trimethylene and the branched alkyl chains  $-\text{CH}(\text{CH}_3)\text{CH}_2-$  and  $-\text{CH}_2-\text{CH}(\text{CH}_3)-$ . The straight chain propylene di-radical is preferred, i.e.  
30  $-\text{CH}_2\text{CH}_2\text{CH}_2-$ . Specific propylene radicals refer to the particular structure, thus the term, propyl-2-ene refers to the group  $-\text{CH}_2-\text{CH}(\text{CH}_3)-$ . Similar notation is used for other divalent alkyl chains such as butylene.

The term '**2-propenyl**' refers to the group  $-\text{CH}_2-\text{CH}=\text{CH}-$ .

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The term "**aryl**" refers to phenyl or naphthyl.

The term "**carbamoyl**" refers to the group  $\text{-C(O)NH}_2$ .

The term "**halo**" refers to fluoro, chloro, bromo or iodo.

The term "**carbocyclyl**" or "**carbocyclic ring**" includes rings of carbon atoms, for example of from 3-12 carbon atoms, which may be saturated, unsaturated (such as aryl or aromatic rings such as phenyl or naphthyl) or partially unsaturated. They may be mono- or bicyclic.

The term "**heterocyclyl**" or "**heterocyclic ring**" refers to a 4-12 membered, preferably 5-10 membered aromatic mono or bicyclic ring or a 4-12 membered, preferably 5-10 membered saturated or partially saturated mono or bicyclic ring, said aromatic, saturated or partially unsaturated rings containing up to 5 heteroatoms independently selected from nitrogen, oxygen or sulphur, linked via ring carbon atoms or ring nitrogen atoms where a bond from a nitrogen is allowed, for example no bond is possible to the nitrogen of a pyridine ring, but a bond is possible through the 1-nitrogen of a pyrazole ring. Examples of 5- or 6-membered aromatic heterocyclic rings include pyrrolyl, furanyl, imidazolyl, triazolyl, pyrazinyl, pyrimidinyl, pyridazinyl, pyridinyl, isoxazolyl, oxazolyl, 1,3,4-oxadiazolyl, isothiazolyl, thiazolyl, thienyl and tetrazolyl. A 9 or 10 membered bicyclic aromatic heterocyclic ring is an aromatic bicyclic ring system comprising a 6-membered ring fused to either a 5 membered ring or another 6 membered ring. Examples of 5/6 and 6/6 bicyclic ring systems include benzofuranyl, benzimidazolyl, benzthiophenyl, benzthiazolyl, benzisothiazolyl, benzoxazolyl, benzisoxazolyl, indolyl, pyridoimidazolyl, pyrimidoimidazolyl, quinoliny, isoquinoliny, quinoxaliny, quinazolinyl, phthalazinyl, cinnoliny and naphthyridinyl. Examples of saturated or partially saturated heterocyclic rings include pyrrolinyl, pyrrolidinyl, morpholinyl, piperidinyl, piperazinyl, dihydropyridinyl, benzodioxyl and dihydropyrimidinyl. This definition further comprises sulphur-containing rings wherein the sulphur atom has been oxidised to an  $\text{S(O)}$  or  $\text{S(O}_2\text{)}$  group.

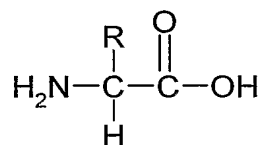
The term "**heteroaryl**" refers to a 5-6 membered aromatic ring or 5-6 membered unsaturated ring containing from 1 to 4 heteroatoms independently selected from O, N and S.

The term "**aromatic ring**" refers to a 5-10 membered aromatic mono or bicyclic ring optionally containing up to 5 heteroatoms independently selected from nitrogen, oxygen or sulphur. Examples of such "aromatic rings" include: phenyl, pyrrolyl, pyrazolyl, furanyl, imidazolyl, triazolyl, pyrazinyl, pyrimidinyl, pyridazinyl, pyridinyl, isoxazolyl, oxazolyl,

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1,2,4 oxadiazolyl, isothiazolyl, thiazolyl and thienyl. Preferred aromatic rings include phenyl, thienyl and pyridyl.

The term “**amino acid derivative**” is defined as that derived from the coupling of an L- or D-amino acid with a carboxyl group via an amide bond. This bond is formed via the amino group on the amino acid backbone. Amino acid residues include those derived from natural and non-natural amino acids, preferably natural amino acids and include  $\alpha$ -amino acids  $\beta$ -amino acids and  $\gamma$ -amino acids. For the avoidance of doubt amino acids include those with the generic structure:



where R is the amino acid side chain. The definition of amino acid also includes amino acid analogues which have additional methylene groups within the amino acid backbone, for example  $\beta$ -alanine and amino acids which are not naturally occurring such as cyclohexylalanine.

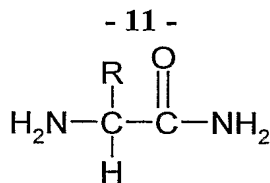
Preferred amino acids include glycine, alanine, valine, leucine, isoleucine, methionine, proline, phenylalanine, tryptophan, serine, threonine, cysteine, tyrosine, asparagine, glutamine, aspartic acid, glutamic acid, lysine, histidine,  $\beta$ -alanine and ornithine. More preferred amino acids include glutamic acid, serine, threonine, glycine, alanine,  $\beta$ -alanine and lysine. Yet more preferred amino acids include: alanine, asparagine, glycine, leucine, methionine, serine and threonine and non-natural amino acids with the following side chains:


$\text{CH}_3\text{-S-CH}_2\text{-}$ ,  $\text{CH}_3\text{-CH}_2\text{-}$ ,  $\text{CH}_3\text{-CH(OH)-}$  and  $\text{HO-CH}_2\text{CH}_2\text{-}$ .

Especially preferred amino acids include alanine, leucine, methionine and serine and non-natural amino acids with the following side chains:  $\text{CH}_3\text{-S-CH}_2\text{-}$ ,  $\text{CH}_3\text{-CH}_2\text{-}$ ,  $\text{CH}_3\text{-CH(OH)-}$  and  $\text{HO-CH}_2\text{CH}_2\text{-}$ .

An amide of an amino acid is defined as amino acid as defined above wherein the carboxy group on the amino acid backbone has been converted to an amide, or where present the carboxyl group on an amino acid side chain has been converted to an amide. Optionally the amino group of the amide group is substituted by  $\text{C}_{1-4}$ alkyl.

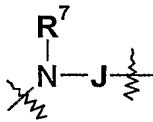
For example, the equivalent generic structure to the generic amino structure above is:

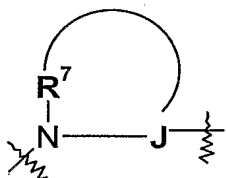


The symbol  denotes where the respective group is linked to the remainder of the molecule.

For the avoidance of doubt where two groups or integers appear within the same  
5 definition, for example,  $-(\text{CH}_2)_s\text{-L}-(\text{CH}_2)_s-$ , then these can be the same or different.

For the avoidance of doubt, where several groups together form a ring, for example:

‘the group  together forms an optionally substituted heterocyclic ring containing 4-7 carbon atoms’, then the groups shown cyclises to form a ring, i.e



For example in Example 5 hereinafter, this group forms a piperazine  
10 ring.

The term **C<sub>1-3</sub>perfluoroalkyl** refers to a C<sub>1-3</sub>alkyl chain in which all hydrogens have been replaced with a fluorine atom. Examples of **C<sub>1-3</sub>perfluoroalkyl** include trifluoromethyl, pentafluoroethyl and 1-trifluoromethyl-1,2,2,2-tetrafluoroethyl. Preferably **C<sub>1-3</sub>perfluoroalkyl** is trifluoromethyl.

15 Examples of **C<sub>1-8</sub>alkyl** include: methyl, ethyl, propyl, isopropyl, butyl, *iso*-butyl, *tert*-butyl and 2-methyl-pentyl; examples of **C<sub>1-8</sub>alkylene** include: methylene, ethylene and 2-methyl-propylene; examples of **C<sub>1-6</sub>alkenyl** include allyl (2-propenyl) and 2-butenyl, examples of **C<sub>1-6</sub>alkynyl** include 2-propynyl and 3-butylnyl, examples of **haloC<sub>1-6</sub>alkyl** include fluoroethyl, chloropropyl and bromobutyl, examples of **hydroxyC<sub>1-6</sub>alkyl** include  
20 hydroxymethyl, hydroxyethyl and hydroxybutyl, examples of **C<sub>1-8</sub>alkoxy** include methoxy, ethoxy and butyloxy; examples of **C<sub>1-4</sub>alkoxyC<sub>1-4</sub>alkyl** include methoxyethyl, propoxybutyl and propoxymethyl, examples of **C<sub>1-6</sub>alkanoyl** include formyl, ethanoyl, propanoyl or pentanoyl, examples of **N-C<sub>1-4</sub>alkylamino** include N-methylamino and N-ethylamino; examples of **N,N-di-C<sub>1-4</sub>alkylamino** include N,N-dimethylaminoethyl,  
25 N,N-dimethylaminopropyl and N,N-dipropylaminoethyl, examples of **HO-C<sub>2-4</sub>alkyl-NH**

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include hydroxymethylamino hydroxyethylamino and hydroxypropylamino, examples of **HO-C<sub>2-4</sub>alkyl-N(C<sub>1-4</sub>alkyl)** include N-methyl-hydroxymethylamino, N-ethyl-hydroxyethylamino, and N-propyl-hydroxypropylamino, examples of **C<sub>1-6</sub>alkyl-S(O<sub>n</sub>)**- include methylthio, methylsulphinyl, ethylsulphinyl, ethylsulphonyl and propylsulphonyl, examples of **arylC<sub>1-6</sub>alkyl** include benzyl, phenethyl and phenylbutyl, examples of **heterocyclylC<sub>1-6</sub>alkyl** include pyrrolidin-1-yl ethyl, imidazolylethyl, pyridylmethyl and pyrimidinylethyl.

It is to be understood that, insofar as certain of the compounds of the invention may exist in optically active or racemic forms by virtue of one or more asymmetric carbon atoms, the invention includes in its definition any such optically active or racemic form which possesses the property of antagonizing gonadotropin releasing hormone (GnRH) activity. The synthesis of optically active forms may be carried out by standard techniques of organic chemistry well known in the art, for example by synthesis from optically active starting materials or by resolution of a racemic form. Similarly, activity of these compounds may be evaluated using the standard laboratory techniques referred to hereinafter.

The invention also relates to any and all tautomeric forms of the compounds of the different features of the invention that possess the property of antagonizing gonadotropin releasing hormone (GnRH) activity.

It will also be understood that certain compounds of the present invention may exist in solvated, for example hydrated, as well as unsolvated forms. It is to be understood that the present invention encompasses all such solvated forms which possess the property of antagonizing gonadotropin releasing hormone (GnRH) activity.

Preferred compounds of Formula (I) are those wherein any one of the following or any combination of the following apply.

Preferably **R<sup>1</sup>** is selected from hydrogen or optionally substituted C<sub>1-6</sub>alkyl, wherein the optional substituents are as described herein. More preferably **R<sup>1</sup>** represents hydrogen or unsubstituted C<sub>1-6</sub>alkyl. Yet more preferably **R<sup>1</sup>** represents hydrogen, methyl, ethyl or *tert*-butyl. Most preferably **R<sup>1</sup>** represents hydrogen.

Most preferably **R<sup>1</sup>** is unsubstituted.

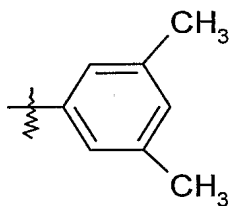
Preferably **R<sup>2</sup>** is an optionally substituted monocyclic aromatic ring structure, wherein the optional substituents are as described herein. Most preferably **R<sup>2</sup>** represents optionally substituted phenyl, wherein the optional substituents are as described herein.

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In another embodiment of the invention  $R^2$  is hydrogen or optionally substituted  $C_{1-6}$ alkyl wherein the optional substituents are as described herein and  $R^1$  is optionally substituted aryl $C_{1-6}$ alkyl, wherein the optional substituents are as describes herein.

Preferably optional substituents on  $R^2$  are independently selected from methyl, ethyl, methoxy, ethoxy, *tert*-butoxy, F or Cl. Most preferably optional substituents on  $R^2$  are independently selected from methyl, F or Cl. Preferably  $R^2$  bears 1, 2 or 3 substituents, most preferably 2 substituents.

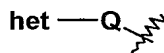
Most preferably  $R^2$  represents



10 Preferably  $R^3$  is selected from a group of Formula (IIc) and Formula (IId). Most preferably  $R^3$  is a group of Formula (IId).

Preferably  $R^4$  is selected from hydrogen, methyl, ethyl, chloro or bromo. Further preferably  $R^4$  is selected from hydrogen or chloro. Most preferably  $R^4$  is hydrogen.

Preferably  $R^5$  is a group of the formula



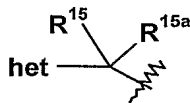
15

wherein:

**het** represents a heteroaryl ring, optionally substituted by from 1 to 2 groups selected from  $R^{12}$  and  $R^{13}$ ; and

**Q** is selected from a direct bond or  $-C(R^{15}R^{15a})-$ .

20 More preferably  $R^5$  is a group of the formula



wherein:

**het** represents a heteroaryl ring, optionally substituted by from 1 to 2 groups selected from  $R^{12}$  and  $R^{13}$ .

25 Preferably **het** is selected from: oxadiazolyl, thienyl, furanyl, thiazolyl, thiadiazolyl, triazolyl, pyrazolyl, imidazolyl, oxazolyl, isoxazolyl, pyridyl, pyrazinyl, pyridazinyl and pyrimidinyl.

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Further preferably **het** is selected from: oxadiazolyl, oxazolyl, triazolyl, imidazolyl, pyrazinyl and pyrimidinyl.

Most preferably **het** is selected from: oxadiazolyl, oxazolyl and triazolyl.

In one embodiment of the invention **het** represents 5-membered heteroaryl.

5 In a further embodiment of the invention **het** represents 6-membered heteroaryl.

Preferably **het** is substituted by hydroxy, hydroxyC<sub>1-8</sub>alkyl, C<sub>1-8</sub>alkyl, C<sub>1-8</sub>alkoxy, C<sub>1-4</sub>alkoxyC<sub>1-4</sub>alkyl, phenyl optionally substituted by C<sub>1-4</sub>alkyl.

More preferably **het** is substituted by ethyl, isopropyl, butyl or 4-methylphenyl.

Most preferably **het** is substituted by ethyl, isopropyl or butyl.

10 Preferably **R**<sup>15</sup> and **R**<sup>15a</sup> are selected from hydrogen and methyl. Most preferably, both **R**<sup>15</sup> and **R**<sup>15a</sup> are methyl.

In one embodiment, **R**<sup>6</sup> and **R**<sup>6a</sup> are independently selected from hydrogen, fluoro, C<sub>1-6</sub>alkyl, C<sub>1-6</sub>alkoxy, or **R**<sup>6</sup> and **R**<sup>6a</sup> taken together with the carbon atom to which they are attached form a carbocyclic ring of 3-7 atoms, or **R**<sup>6</sup> and **R**<sup>6a</sup> taken together with the carbon  
15 atom to which they are attached form a carbonyl group.

Preferably **R**<sup>6</sup> and **R**<sup>6a</sup> are independently selected from hydrogen, fluoro, optionally substituted C<sub>1-6</sub>alkyl (wherein any optional substituents are selected from **R**<sup>12</sup>) or **R**<sup>6</sup> and **R**<sup>6a</sup> taken together and the carbon atom to which they are attached form a carbocyclic ring of 3-7 atoms. For instance, **R**<sup>6</sup> and **R**<sup>6a</sup> are independently selected from hydrogen, fluoro, C<sub>1-6</sub>alkyl,  
20 C<sub>1-6</sub>alkoxy, or **R**<sup>6</sup> and **R**<sup>6a</sup> taken together and the carbon atom to which they are attached form a carbocyclic ring of 3-7 atoms. More preferably **R**<sup>6</sup> and **R**<sup>6a</sup> are independently selected from hydrogen, unsubstituted C<sub>1-6</sub>alkyl or **R**<sup>6</sup> and **R**<sup>6a</sup> taken together and the carbon atom to which they are attached form a carbocyclic ring of 3-7 atoms. Yet more preferably **R**<sup>6</sup> and **R**<sup>6a</sup> are independently selected from hydrogen, methyl or **R**<sup>6</sup> and **R**<sup>6a</sup> taken together and the carbon  
25 atom to which they are attached form cyclopropyl. Further preferably **R**<sup>6</sup> is hydrogen and **R**<sup>6a</sup> is methyl. Most preferably **R**<sup>6</sup> and **R**<sup>6a</sup> are both hydrogen.

In a particular embodiment, at least one of **R**<sup>6</sup> or **R**<sup>6a</sup> is selected from C<sub>1-6</sub>alkoxy, N-C<sub>1-6</sub>alkylamino and N,N-diC<sub>1-6</sub>alkylamino, suitably C<sub>1-6</sub>alkoxy such as methoxy. The other of **R**<sup>6</sup> or **R**<sup>6a</sup> is preferably hydrogen.

30 Preferably **R**<sup>7</sup> is selected from: hydrogen or C<sub>1-4</sub>alkyl. More preferably **R**<sup>7</sup> is hydrogen or methyl. Most preferably **R**<sup>7</sup> is hydrogen.

Preferably **R**<sup>8</sup> is selected from

## - 15 -

- (i) hydrogen, C<sub>1-6</sub>alkyl, C<sub>2-6</sub>alkenyl, haloC<sub>1-6</sub>alkyl, hydroxy, cyano, C<sub>1-6</sub>alkylS(O<sub>n</sub>)-, -O-R<sup>b</sup>, C<sub>1-4</sub>alkoxyC<sub>1-4</sub>alkyl, -C(O)-R<sup>b</sup>, C(O)O-R<sup>b</sup>, -NH-C(O)-R<sup>b</sup>, N,N-di-C<sub>1-4</sub>alkylamino, -S(O<sub>n</sub>)NR<sup>b</sup>R<sup>c</sup> where R<sup>b</sup> and R<sup>c</sup> are independently selected from hydrogen and C<sub>1-6</sub>alkyl, and n is 0, 1 or 2;
- (ii) C<sub>4-7</sub>heterocyclyl, optionally substituted by up to 3 groups selected from R<sup>12</sup> and R<sup>13</sup>, such as aziriny, azetidiny, pyrrolidiny, pyrazoliny, pyrazolidiny, imidazoliny, imidazolidiny, piperidiny, piperaziny, hexahydropyrimidiny, hexahydropyridaziny, hexahydrotriaziny, tetrahydrotriaziny, dihydrotriaziny, tetrahydrofurany, dioxolany, tetrahydropyrany, dioxany, trioxany, tetrahydrothieny, 1-oxotetrahydrothieny, 1,1-dioxotetrahydrothieny tetrahydrothiopyran, 1-oxotetrahydrothiopyran, 1,1-dioxotetrahydrothiopyran, dithiany, trithiany, morpholiny, oxathiolany, oxathiany, thiomorpholiny, thiazinany, 1-oxo-thiomorpholiny, 1,1-dioxo-thiomorpholiny, thiazolidiny, pyrroly, imidazolyl, triazolyl, pyridyl, pyrimidiny, pyraziny, pyridaziny, triaziny, thiazolyl, thiadiazolyl, thiadiaziny, oxazolyl, isoxazolyl, oxadiazolyl, furazany, octahydropyrrolopyrroly, octahydropyrrolopyrroly, benzotriazolyl, dihydrobenzotriazolyl, indolyl, indoliny, benzimidazolyl, 2,3-dihydrobenzimidazolyl, benzotriazolyl 2,3-dihydro benzotriazolyl quinoliny, isoquinoliny, cinnoliny, phthalaziny, quinazoliny, quinozaliny, naphthyridiny, pteridiny, benzodioxolyl, tetrahydrodioxolopyrroly, 1,5-dioxo-9-azaspiro[5.5]undecany or 8-oxa-3-azabicyclooctany; each of which is optionally substituted by up to 3 groups selected from R<sup>12</sup> and R<sup>13</sup> or
- (iii) phenyl or C<sub>3-7</sub>carbocyclyl; each of which is optionally substituted by up to 3 groups selected from R<sup>12</sup> and R<sup>13</sup>;

Further preferably R<sup>8</sup> is selected from

- (i) hydrogen, C<sub>1-6</sub>alkyl, C<sub>2-6</sub>alkenyl, haloC<sub>1-6</sub>alkyl, hydroxy, cyano, C<sub>1-6</sub>alkylS(O<sub>n</sub>)-, -O-R<sup>b</sup>, C<sub>1-4</sub>alkoxyC<sub>1-4</sub>alkyl, -C(O)-R<sup>b</sup>, C(O)O-R<sup>b</sup>, -NH-C(O)-R<sup>b</sup>, N,N-di-C<sub>1-4</sub>alkylamino, -S(O<sub>n</sub>)NR<sup>b</sup>R<sup>c</sup> where R<sup>b</sup> and R<sup>c</sup> are independently selected from hydrogen and C<sub>1-6</sub>alkyl, and n is 0, 1 or 2; such as hydrogen, methyl, isopropyl, *t*-butyl, 1-methylethyl, allyl, fluoroethyl, hydroxy, cyano, ethylsulphonyl, methoxy, 1-methyl-2-methoxyethyl, acetyl, *t*-butoxycarbonyl, acetylamino, dimethylamino, diethylamino, (1-methylethyl)amino, isopropylamino or aminosulphonyl;



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- (ii) azetidiny, furanyl, tetrahydrofuranyl, tetrahydropyranyl, pyrrolidinyl, piperidinyl, piperazinyl, hexahydropyrimidinyl, morpholinyl, tetrahydrothienyl, 1,1-dioxotetrahydrothienyl, thiomorpholinyl, 1-oxo-thiomorpholinyl, 1,1-dioxo-thiomorpholinyl, imidazolyl, triazolyl, thienyl, thiazolyl, isoxazolyl, pyridyl, pyrimidinyl, pyrazinyl, tetrahydro-3aH-[1,3]dioxolo[4,5-c]pyrrolyl, 1,5-dioxa-9-azaspiro[5.5]undecanyl, 8-oxa-3-azabicyclo[3.2.1]octanyl, benzodioxolyl, 2,3-dihydrobenzotriazolyl, 1,2-dihydroquinolinyl or octahydropyrrolo[3,4-c]pyrrolyl; each of which is optionally substituted by up to 3 groups selected from  $R^{12}$  and  $R^{13}$ ; or

- 10 (iii) phenyl or  $C_{3-7}$ carbocyclyl, each of which is optionally substituted by up to 3 groups selected from  $R^{12}$  and  $R^{13}$ ;

Yet further preferably  $R^8$  is selected from

- (i) phenyl optionally substituted by up to 3 groups selected from  $R^{12}$  and  $R^{13}$ ;
- (ii) furanyl, tetrahydropyranyl, pyrrolidinyl, piperazinyl, morpholinyl, 1,1-dioxo-thiomorpholinyl, thienyl, triazolyl, pyridyl, pyrimidinyl, pyrazinyl, tetrahydro-3aH-[1,3]dioxolo[4,5-c]pyrrolyl, benzodioxolyl, 1,2-dihydroquinolinyl or 2,3-dihydrobenzotriazolyl; each of which is optionally substituted by up to 3 groups selected from  $R^{12}$  and  $R^{13}$ ; or
- 15 (iii)  $C_{3-7}$ carbocyclyl (preferably cyclohexyl or cyclopentyl, more preferably cyclohexyl) optionally substituted by up to 3 groups selected from  $R^{12}$  and  $R^{13}$ ;
- 20

Yet further preferably  $R^8$  is selected from optionally substituted  $C_{4-7}$ heterocyclyl selected from: piperidinyl or piperazinyl, azetidiny, imidazolyl and thiazolyl, wherein the optional substituents are selected from  $R^{12}$  and  $R^{13}$

Most preferably  $R^8$  is optionally substituted  $C_{4-7}$ heterocyclyl selected from: piperidinyl or piperazinyl, wherein the optional substituents are selected from  $R^{12}$  and  $R^{13}$ .

25

More preferably optional substituents on  $R^8$  are selected from: cyano, hydroxy, oxo, nitro, halo, trifluoromethyl,  $C_{1-4}$ alkyl,  $C_{1-4}$ alkoxy,  $C_{1-4}$ alkanoyl,  $R^9OC(O)(CH_2)_w-$ ,  $R^9R^{10}N(CH_2)_w-$ ,  $R^9R^{10}NC(O)(CH_2)_w-$ ,  $R^9R^{10}NC(O)N(R^9)(CH_2)_w-$ ,  $R^9OC(O)N(R^9)(CH_2)_w-$ , or halo, wherein  $w$  is an integer between 0 and 4 and  $R^9$  and  $R^{10}$  are selected from: hydrogen,  $C_{1-4}$ alkyl,  $C_{1-4}$ alkylsulphonyl and  $C_{3-7}$ carbocyclyl.

30

Further preferably optional substituents on  $R^8$  are selected from: cyano, hydroxy, oxo, amino,  $N,N$ -di- $C_{1-4}$ alkylamino,  $N,N$ -di- $C_{1-4}$ alkylamino- $C_{1-4}$ alkyl,  $N'$ - $C_{1-4}$ alkylureido,  $N$ - $C_{1-4}$ alkylsulphonylamino,  $N,N$ -di- $C_{1-4}$ alkylsulphonylamino, nitro, halo, trifluoromethyl,

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C<sub>1-4</sub>alkyl, C<sub>1-4</sub>alkoxy, C<sub>1-4</sub>alkanoyl, C<sub>1-4</sub>alkoxycarbonylamino and C<sub>3-7</sub>carbocyclylcarbonylamino.

- More preferably optional substituents on **R**<sup>8</sup> are selected from: cyano, hydroxy, oxo, methyl, ethyl, *t*-butyl, methoxy, acetyl, amino, N,N-dimethylamino, N'-isopropylureido, N'-cyclohexylureido, N-methylsulphonylamino, N,N-dimethylsulphonylamino, nitro, chloro, fluoro, trifluoromethyl and isopropoxycarbonylamino.

Further preferably optional substituents on **R**<sup>8</sup> are selected from: hydroxy, methyl, ethyl, methoxy, fluoro, methylsulphonylamino and isopropoxycarbonylamino. Most preferably optional substituents on **R**<sup>8</sup> are selected from: hydroxy.

- 10 In a further embodiment of the invention optional substituents on **R**<sup>8</sup> are selected from: C<sub>1-4</sub>alkoxy, fluoro, C<sub>1-4</sub>alkylsulphonylamino, C<sub>1-4</sub>alkanoylamino, C<sub>1-4</sub>alkylureido and C<sub>1-4</sub>alkoxycarbonylamino.

In a further embodiment of the invention when **R**<sup>8</sup> is phenyl then **R**<sup>8</sup> is preferably substituted and when **R**<sup>8</sup> is a heterocyclic ring **R**<sup>8</sup> is preferably unsubstituted.

- 15 In one embodiment, **R**<sup>11</sup> is selected from: hydrogen, optionally substituted C<sub>1-6</sub>alkyl or N(**R**<sup>23</sup>**R**<sup>24</sup>), where **R**<sup>23</sup> and **R**<sup>24</sup> are as defined above.

Particular examples of **R**<sup>11</sup> is hydrogen or optionally substituted C<sub>1-6</sub>alkyl where the optional substituents on the alkyl

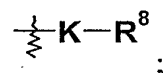
groups are selected from **R**<sup>12</sup> and  $\frac{1}{\sum} \text{K}-\text{R}^8$

- 20 In a further embodiment, **R**<sup>11</sup> is a group NR<sup>23</sup>R<sup>24</sup>.

Suitably **R**<sup>23</sup> is selected from hydrogen, optionally substituted aryl, optionally substituted 3-10 membered heterocyclic ring or an optionally substituted C<sub>1-8</sub>alkyl, wherein optional substituents are as defined above.

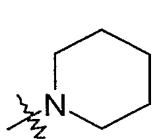
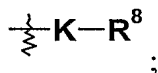
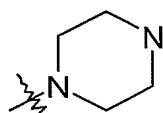
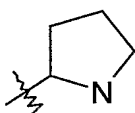
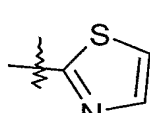
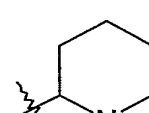
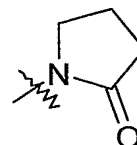
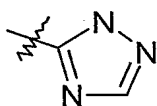
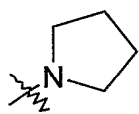
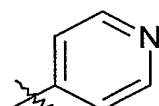
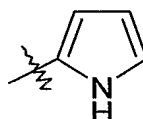
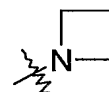
Suitably **R**<sup>24</sup> is selected from hydrogen or optionally substituted C<sub>1-8</sub>alkyl,

- 25 When **R**<sup>23</sup> or **R**<sup>24</sup>, but particularly **R**<sup>23</sup> is a C<sub>1-8</sub>alkyl group, such as a C<sub>1-6</sub>alkyl group, it is suitably optionally substituted 3 to 10 membered heterocyclic ring containing from 1 to 4 heteroatoms independently selected from O, N and S, the heterocyclic ring is preferably selected from pyridyl, thienyl, piperidiny, imidazolyl, triazolyl, thiazolyl, pyrrolidiny, piperazinyl, morpholinyl, imidazoliny, benzotriazolyl, benzimidazolyl, pyrimidinyl, pyrazinyl, pyridazinyl, oxazolyl, furanyl, pyrrolyl, 1,3-dioxolanyl, 2-azetiny, each of which is optionally substituted, wherein the optional substituents are preferably selected from **R**<sup>12</sup> and

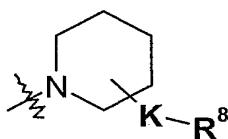
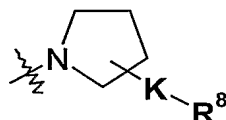


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Further preferably the heterocyclic ring is a group of formula **VI-a**, **VI-b**, **VI-c**, **VI-d**, **VI-e**, **VI-f**, **VI-g**, **VI-h**, **VI-i**, **VI-j** or **VI-k**; wherein each group is optionally substituted by one or more groups selected from  $R^{12}$  and

**VI-a****VI-b****VI-c****VI-d****VI-e****VI-f****VI-g****VI-h****VI-i****VI-j****VI-k**

Most preferably the heterocyclic ring is a group of formula **VI-a** or **VI-h**, wherein each group is optionally substituted by one or more groups selected from  $R^{12}$

**VI-a****VI-h**

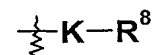
10 Preferably  $R^{24}$  is optionally substituted  $C_{1-6}$ alkyl, or together with  $R^{23}$  and the nitrogen atom to which they are attached, forms an optionally substituted heterocyclic ring of 3-10 atoms. Further preferably  $R^{24}$  is selected from: methyl, ethyl or tert-butyl, or together with  $R^{23}$  and the nitrogen atom to which they are attached, forms an optionally substituted heterocyclic ring of 3-10 atoms. Most preferably  $R^{24}$  together with  $R^{23}$  and the nitrogen atom  
15 to which they are attached, forms an optionally substituted heterocyclic ring of 3-10 atoms.

When  $N(R^{23}R^{24})$  represents an optionally substituted 3- to 10-membered heterocyclic ring, for instance a 3-9 membered heterocyclic ring,  $N(R^{23}R^{24})$  is preferably selected from a 5- or 6-membered monocyclic ring containing between 1 and 3 (preferably 1 or 2)

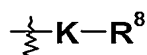
heteroatoms independently selected from O, N and S, wherein the optional substituents are

20 independently selected from  $R^{12}$  and

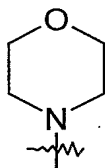
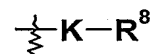
- 19 -



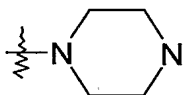
Further preferably  $\text{N}(\text{R}^{23}\text{R}^{24})$  represents a 5- or 6-membered monocyclic ring containing between 1 and 3 (preferably 1 or 2) heteroatoms independently selected from O, N and S selected from pyrrolidinyl, thienyl, pyrazolidinyl, piperidinyl, morpholinyl, thiomorpholinyl  
 5 piperazinyl, imidazole, or azetidiny, wherein the optional substituents are independently selected from  $\text{R}^{12}$  and



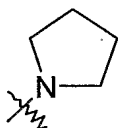
Further preferably the structure  $\text{N}(\text{R}^{23}\text{R}^{24})$  is a heterocyclic ring selected from an optionally substituted group of formula, IV-a, IV-b, IV-c, IV-d and IV-e, wherein each group  
 10 is optionally substituted by one or more groups selected from  $\text{R}^{12}$  and



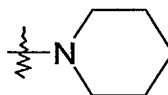
IV-a



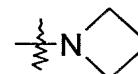
IV-b



IV-c

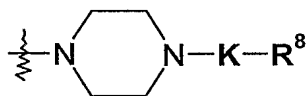


IV-d

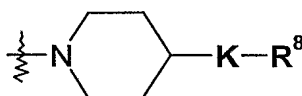


IV-e

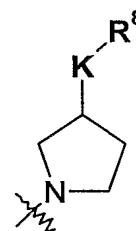
Further preferably the structure  $\text{N}(\text{R}^{23}\text{R}^{24})$  is selected from a group of formula Va, Vb or Vc, wherein each group is optionally substituted by one or more groups selected from  $\text{R}^{12}$ .



V-a



V-b



V-c

15

where  $\text{K}$  and  $\text{R}^8$  are as defined above.

Most preferably the structure  $\text{N}(\text{R}^{23}\text{R}^{24})$  is a group of formula V-b or V-c, wherein each group is optionally substituted by one or more groups selected from  $\text{R}^{12}$ .

$\text{R}^{11}$  may also be a group  $\text{NC}(\text{O})\text{OR}^{25}$ .  $\text{R}^{25}$  is suitably optionally substituted  $\text{C}_{1-6}$ alkyl,  
 20 and in particular unsubstituted  $\text{C}_{1-4}$ alkyl.

Preferably  $\text{R}^{14}$  is hydrogen or methyl. Most preferably  $\text{R}^{14}$  is hydrogen.

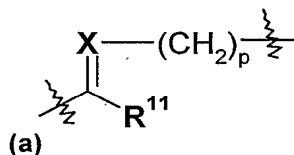
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Preferably **A** is selected from a direct bond, optionally substituted C<sub>1-5</sub>alkylene, carbonyl or -C(O)-C(R<sup>d</sup>R<sup>d</sup>)-, wherein R<sup>d</sup> is independently selected from hydrogen and C<sub>1-2</sub>alkyl, and wherein the optional substituents are independently selected from: hydroxy, hydroxyC<sub>1-6</sub>alkyl, C<sub>1-6</sub>alkyl, C<sub>1-6</sub>alkoxy, C<sub>1-4</sub>alkoxyC<sub>1-4</sub>alkyl, aryl or arylC<sub>1-6</sub>alkyl

5 Further preferably **A** is selected from C<sub>1-5</sub>alkylene optionally substituted with C<sub>1-4</sub>alkyl or C<sub>1-4</sub>alkoxy, carbonyl or carbonylmethyl. Yet further preferably **A** is a direct bond or methylene. Most preferably **A** is methylene.

Suitably, **B** is selected from:

- (i) a direct bond;  
 10 (ii) a group of Formula (IV)



Formula (IV)

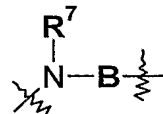
wherein:

- X** is selected from N or CH,  
 15 wherein at position (a) Formula (IV) is attached to the nitrogen atom and the (CH<sub>2</sub>)<sub>p</sub> group is attached to R<sup>8</sup>; and  
 (iii) a group independently selected from: optionally substituted C<sub>1-6</sub>alkylene, optionally substituted C<sub>3-7</sub>cycloalkyl, optionally substituted C<sub>3-6</sub>alkenylene, optionally substituted C<sub>3-6</sub>alkynyl, (C<sub>1-5</sub>alkyl)<sub>aa</sub>-S(O<sub>n</sub>)-(C<sub>1-5</sub>alkyl)<sub>bb</sub>-,  
 20 -(C<sub>1-5</sub>alkyl)<sub>aa</sub>-O-(C<sub>1-5</sub>alkyl)<sub>bb</sub>-, -(C<sub>1-5</sub>alkyl)<sub>aa</sub>-C(O)-(C<sub>1-5</sub>alkyl)<sub>bb</sub>- or (C<sub>1-5</sub>alkyl)<sub>aa</sub>-N(R<sup>14</sup>)-(C<sub>1-5</sub>alkyl)<sub>bb</sub>, or (C<sub>1-5</sub>alkyl)<sub>aa</sub>-C(O)N(R<sup>14</sup>)-(C<sub>1-5</sub>alkyl)<sub>bb</sub>,  
 wherein R<sup>14</sup> is hydrogen or C<sub>1-4</sub>alkyl, or R<sup>14</sup> and the (C<sub>1-5</sub>alkyl)<sub>aa</sub> or (C<sub>1-5</sub>alkyl)<sub>bb</sub> chain can be joined to form a heterocyclic ring, wherein aa and bb are independently 0 or 1, and the combined length of (C<sub>1-5</sub>alkyl)<sub>aa</sub> and (C<sub>1-5</sub>alkyl)<sub>bb</sub> is less than or equal to C<sub>5</sub>alkyl and wherein  
 25 the optional substituents are independently selected from R<sup>12</sup>.

Particular examples of R<sup>11</sup> include hydrogen, C<sub>1-4</sub>alkyl or N(R<sup>23</sup>R<sup>24</sup>), where R<sup>23</sup> and R<sup>24</sup> are independently selected from hydrogen or C<sub>1-4</sub>alkyl.

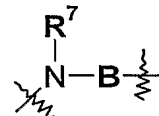
Preferably **B** is selected from optionally substituted C<sub>1-6</sub>alkylene, optionally substituted C<sub>3-6</sub>alkenylene, -(C<sub>1-5</sub>alkyl)<sub>aa</sub>-O-(C<sub>1-5</sub>alkyl)<sub>bb</sub>-, -(C<sub>1-5</sub>alkyl)<sub>aa</sub>-C(O)-(C<sub>1-5</sub>alkyl)<sub>bb</sub>-,

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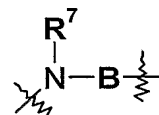
-(CH<sub>2</sub>)<sub>s1</sub>-C(O)N(R<sup>14</sup>)-(CH<sub>2</sub>)<sub>s2</sub>-, or the group forms an optionally substituted C<sub>4-7</sub>heterocyclic ring, wherein **aa** and **bb** are independently 0 to 1.

More preferably **B** is C<sub>1-6</sub>alkylene, C<sub>3-6</sub>alkenylene, -(C<sub>1-5</sub>alkyl)<sub>aa</sub>-O-(C<sub>1-5</sub>alkyl)<sub>bb</sub>-,



-(C<sub>1-5</sub>alkyl)<sub>aa</sub>-C(O)-(C<sub>1-5</sub>alkyl)<sub>bb</sub>-, -(CH<sub>2</sub>)<sub>aa</sub>-C(O)N(R<sup>14</sup>)-, or the group forms an optionally substituted saturated C<sub>4-7</sub>heterocyclic ring, wherein R<sup>14</sup> is as defined above, **aa** and **bb** are independently 0 or 1 and wherein C<sub>1-6</sub>alkylene is optionally substituted by hydroxy.

Further preferably **B** is unsubstituted C<sub>1-6</sub>alkylene, C<sub>3-6</sub>alkenylene



-(C<sub>1-5</sub>alkyl)<sub>aa</sub>-O-(C<sub>1-5</sub>alkyl)<sub>bb</sub>-, -(C<sub>1-5</sub>alkyl)<sub>aa</sub>-C(O)- or the group forms an optionally substituted saturated C<sub>4-7</sub>heterocyclic ring selected from: azetidiny, pyrrolidiny, pyrazoliny, pyrazolidiny, imidazoliny, imidazolidiny, piperidiny, piperaziny, hexahydropyrimidiny, hexahydropyridaziny, hexahydrotriaziny, tetrahydrotriaziny, dihydrotriaziny, morpholiny, thiomorpholiny, thiazinany, thiazolidiny, 1,5-dioxa-9-azaspiro[5.5]undecany or octahydropyrrolopyrroly, wherein the optional substituents are selected from cyano, halo, hydroxy, oxo, C<sub>1-4</sub>alkyl, C<sub>1-4</sub>alkoxy, C<sub>1-4</sub>alkanoyl, carboxyl, C<sub>1-6</sub>alkoxycarbonylC<sub>0-4</sub>alkyl, aminocarbonylC<sub>0-4</sub>alkyl, N-C<sub>1-6</sub>alkylaminocarbonylC<sub>0-4</sub>alkyl or N, N-C<sub>1-6</sub>alkylaminocarbonylC<sub>0-4</sub>alkyl.

Particular optional substituents for the group **B** are carboxyl,

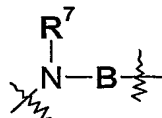
C<sub>1-6</sub>alkoxycarbonylC<sub>0-4</sub>alkyl, aminocarbonylC<sub>0-4</sub>alkyl, N-C<sub>1-6</sub>alkylaminocarbonylC<sub>0-4</sub>alkyl or N, N-C<sub>1-6</sub>alkylaminocarbonylC<sub>0-4</sub>alkyl groups of formula R<sup>19</sup>OC(O)(CH<sub>2</sub>)<sub>w</sub>-,

R<sup>19</sup>R<sup>20</sup>NC(O)(CH<sub>2</sub>)<sub>w</sub>- where w is an integer between 0 and 4, and R<sup>19</sup> and R<sup>20</sup> are independently selected from hydrogen and C<sub>1-4</sub>alkyl. More preferably R<sup>19</sup> and R<sup>20</sup> are independently selected from hydrogen, methyl and ethyl. Most preferably R<sup>19</sup> and R<sup>20</sup> are both methyl.

Yet further preferably **B** is selected from: methylene, ethylene, propylene,

propyl-2-ene, butylene, pentylene, 2-propenyl, propoxyene, ethoxyethylene, methylcarbonyl or methylcarbonylamino.

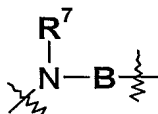
- 22 -



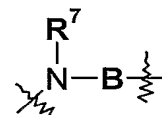
Alternatively, the group forms a C<sub>4-7</sub>heterocyclic ring selected from: pyrrolidinyl, piperidinyl, or piperazinyl, wherein the optional substituents are selected from oxo.

Most preferably **B** is selected from ethylene or butylene.

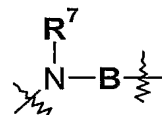
5 In another embodiment of the invention preferably **B** is selected from optionally



substituted C<sub>1-6</sub>alkylene or the group forms a C<sub>5-7</sub>heterocyclic ring. Preferably



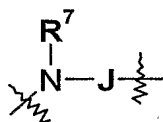
**B** is selected from unsubstituted C<sub>1-6</sub>alkylene or the group forms a saturated C<sub>5-7</sub>heterocyclic ring. Most preferably **B** is selected from methylene, ethylene, propylene,



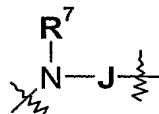
butylene or or the group forms a saturated C<sub>5-7</sub>heterocyclic ring selected from

10 piperidinyl or piperazinyl.

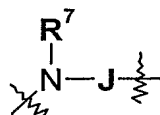
When **R**<sup>3</sup> is selected from a group of Formula (IIc) or Formula (IId) then the group



preferably forms an optionally substituted heterocyclic ring containing 4-7 carbons atoms, wherein the optional substituents are selected from 1 or 2 substituents independently selected from **R**<sup>12</sup> and **R**<sup>13</sup>.



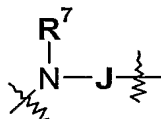
15 More preferably the group forms an optionally substituted saturated C<sub>4-7</sub>heterocyclic ring wherein the optional substituents are selected from 1 or 2 substituents independently selected from **R**<sup>12</sup> and **R**<sup>13</sup>.



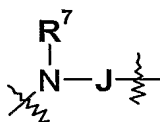
Further preferably the group forms an optionally substituted saturated C<sub>4-7</sub>heterocyclic ring selected from: azetidiny, pyrrolidinyl, pyrazolinyl, pyrazolidinyl,

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imidazoliny, imidazolidiny, piperidiny, piperaziny, hexahydropyrimidiny, hexahydropyridaziny, hexahydrotriaziny, tetrahydrotriaziny, dihydrotriaziny, morpholiny, thiomorpholiny, thiazinany, thiazolidiny or octahydropyrrolopyrroly, wherein the optional substituents are selected from oxo, C<sub>1-4</sub>alkyl and C<sub>1-4</sub>alkoxy.



- 5 Further preferably the group forms an optionally substituted saturated C<sub>4-7</sub>heteocyclic ring selected from: pyrrolidiny, piperidiny or piperaziny, wherein the optional substituents are selected from C<sub>1-4</sub>alkoxy.



Most preferably the group forms an optionally substituted saturated C<sub>4-7</sub>heteocyclic ring selected from: piperaziny.

- 10 Within the group **K**, each **R**<sup>21</sup> and **R**<sup>22</sup> is independently selected from hydrogen, hydroxy or C<sub>1-4</sub>alkyl, which is optionally substituted by a group **ZR**<sup>30</sup> where **Z** is oxygen or a group S(O)<sub>n</sub> where n is as described above, and **R**<sup>30</sup> is hydrogen or C<sub>1-4</sub>alkyl. Particular examples of **R**<sup>30</sup> are hydrogen or methyl. Preferably in this case, the integer n is 0. Suitable examples of the group **ZR**<sup>30</sup> are hydroxy and thiomethyl. In a particular embodiment of the
- 15 invention, at least one group **R**<sup>21</sup> or **R**<sup>22</sup> is C<sub>1-4</sub>alkyl substituted by a group **ZR**<sup>30</sup>.

Where one of **R**<sup>21</sup> or **R**<sup>22</sup> is C<sub>1-4</sub>alkyl substituted by a group **ZR**<sup>30</sup>, the other is suitably hydrogen.

In an alternative embodiment, both **R**<sup>21</sup> and **R**<sup>22</sup> are C<sub>1-4</sub>alkyl such as methyl.

- Preferably **K** is selected from: a direct bond, -(CH<sub>2</sub>)<sub>s</sub>-, -(CH<sub>2</sub>)<sub>s</sub>-O-(CH<sub>2</sub>)<sub>s</sub>-,
- 20 -(CH<sub>2</sub>)<sub>s</sub>-C(O)-(CH<sub>2</sub>)<sub>s</sub>-, -(CH<sub>2</sub>)<sub>s</sub>-N(**R**<sup>14</sup>)-(CH<sub>2</sub>)<sub>s</sub>-, -(CH<sub>2</sub>)<sub>s</sub>-C(O)N(**R**<sup>14</sup>)-(CH<sub>2</sub>)<sub>s</sub>-,
- (CH<sub>2</sub>)<sub>s</sub>-N(**R**<sup>14</sup>)C(O)-(CH<sub>2</sub>)<sub>s</sub>-, -(CH<sub>2</sub>)<sub>s</sub>-S(O)<sub>2</sub>N(**R**<sup>14</sup>)-(CH<sub>2</sub>)<sub>s</sub>-, or -(CH<sub>2</sub>)<sub>s</sub>-NHS(O)<sub>2</sub>-(CH<sub>2</sub>)<sub>s</sub>-,
- wherein s is independently selected from 0, 1, 2, 3 or 4, **R**<sup>14</sup> is selected from hydrogen or C<sub>1-4</sub>alkyl (preferably hydrogen) and the -(CH<sub>2</sub>)<sub>s</sub>- group is optionally substituted by hydroxy or C<sub>1-4</sub>alkyl.

- 25 More preferably **K** is selected from: a direct bond, -(CH<sub>2</sub>)<sub>s</sub>-, -(CH<sub>2</sub>)<sub>s</sub>-O-(CH<sub>2</sub>)<sub>s</sub>-,
- (CH<sub>2</sub>)<sub>s</sub>-C(O)-, -C(O)-(CH<sub>2</sub>)<sub>s</sub>-, -(CH<sub>2</sub>)<sub>s</sub>-N(**R**<sup>14</sup>)-, -(CH<sub>2</sub>)<sub>s</sub>-C(O)N(**R**<sup>14</sup>)-,
- (CH<sub>2</sub>)<sub>s</sub>-N(**R**<sup>14</sup>)C(O)-(CH<sub>2</sub>)<sub>s</sub>-, -(CH<sub>2</sub>)<sub>s</sub>-S(O)<sub>2</sub>N(**R**<sup>14</sup>)- or -(CH<sub>2</sub>)<sub>s</sub>-NHS(O)<sub>2</sub>-,
- wherein s is independently selected from 0,1,2,3 or 4, **R**<sup>14</sup> is selected from hydrogen or



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C<sub>1-4</sub>alkyl (preferably hydrogen or methyl) and the -(CH<sub>2</sub>)<sub>s</sub>- group is optionally substituted by hydroxy or C<sub>1-4</sub>alkyl.

More preferably **K** is selected from: a direct bond, methylene, ethylene, propylene, butylene, oxy, 2-hydroxypropylene, carbonyl, methylcarbonyl, ethylcarbonyl,

- 5 (methyl)methylcarbonyl, (ethyl)methylcarbonyl, carbonylmethylene, carbonylethylene, ethoxyethylene, amino, 2-hydroxypropylamino, carbonylamino, methylcarbonylamino, N-methyl-methylcarbonylamino, aminocarbonyl, methylaminocarbonyl, methylaminocarbonylmethyl, propylsulphonylamino or methylaminosulphonyl.

- Further preferably **K** is selected from: a direct bond, methylene, ethylene, propylene, butylene carbonyl, methylcarbonyl or N-methylmethylcarbonylamino.

Further preferably **K** is selected from: a direct bond, methyl, carbonyl and methylcarbonyl.

In an particular embodiment, using an alternative representation, **K** is selected from: a direct bond, -(CH<sub>2</sub>)<sub>s1</sub>-, -(CH<sub>2</sub>)<sub>s1</sub>-O-(CH<sub>2</sub>)<sub>s2</sub>-, -(CH<sub>2</sub>)<sub>s1</sub>-C(O)-(CH<sub>2</sub>)<sub>s2</sub>-,

- 15 -(CH<sub>2</sub>)<sub>s1</sub>-S(O<sub>n</sub>)-(CH<sub>2</sub>)<sub>s2</sub>-, -(CH<sub>2</sub>)<sub>s1</sub>-N(R<sup>17</sup>)-(CH<sub>2</sub>)<sub>s2</sub>-, -(CH<sub>2</sub>)<sub>s1</sub>-C(O)N(R<sup>17</sup>)-(CH<sub>2</sub>)<sub>s2</sub>-,  
 -(CH<sub>2</sub>)<sub>s1</sub>-N(R<sup>17</sup>)C(O)-(CH<sub>2</sub>)<sub>s2</sub>-, -(CH<sub>2</sub>)<sub>s1</sub>-N(R<sup>17</sup>)C(O)N(R<sup>17</sup>)-(CH<sub>2</sub>)<sub>s2</sub>-,  
 -(CH<sub>2</sub>)<sub>s1</sub>-OC(O)-(CH<sub>2</sub>)<sub>s2</sub>-, -(CH<sub>2</sub>)<sub>s1</sub>-C(O)O-(CH<sub>2</sub>)<sub>s2</sub>-, -(CH<sub>2</sub>)<sub>s1</sub>-N(R<sup>17</sup>)C(O)O-(CH<sub>2</sub>)<sub>s2</sub>-,  
 -(CH<sub>2</sub>)<sub>s1</sub>-OC(O)N(R<sup>17</sup>)-(CH<sub>2</sub>)<sub>s2</sub>-, -(CH<sub>2</sub>)<sub>s1</sub>-OS(O<sub>n</sub>)-(CH<sub>2</sub>)<sub>s2</sub>-, or -(CH<sub>2</sub>)<sub>s1</sub>-S(O<sub>n</sub>)-O-(CH<sub>2</sub>)<sub>s2</sub>-,  
 -(CH<sub>2</sub>)<sub>s1</sub>-S(O)<sub>2</sub>N(R<sup>17</sup>)-(CH<sub>2</sub>)<sub>s2</sub>- or -(CH<sub>2</sub>)<sub>s1</sub>-N(R<sup>17</sup>)S(O)<sub>2</sub>-(CH<sub>2</sub>)<sub>s2</sub>-; wherein the -(CH<sub>2</sub>)<sub>s1</sub>- and  
 20 -(CH<sub>2</sub>)<sub>s2</sub>- groups are independently optionally substituted by hydroxy or C<sub>1-4</sub>alkyl group and wherein when s<sub>1</sub>>1 or s<sub>2</sub>>1 then the CH<sub>2</sub> group can optionally be a branched chain.

- For the avoidance of doubt, it should be made clear that where it is stated that a CH<sub>2</sub> group within a -(CH<sub>2</sub>)<sub>s1</sub>- or -(CH<sub>2</sub>)<sub>s2</sub>- is di-substituted with C<sub>1-4</sub>alkyl, it means that both hydrogens within the CH<sub>2</sub> group are replaced by C<sub>1-4</sub>alkyl groups, such as methyl or ethyl groups. In particular, when the compound of formula (I) includes a group **K** wherein the -(CH<sub>2</sub>)<sub>s1</sub>- and -(CH<sub>2</sub>)<sub>s2</sub>- groups are independently optionally substituted, these are suitably optionally substituted by hydroxy or C<sub>1-4</sub>alkyl.

- Particular examples of groups R<sup>12</sup> include hydroxy, hydroxyC<sub>1-6</sub>alkyl, oxo, cyano, cyanoC<sub>1-6</sub>alkyl, nitro, carboxyl, C<sub>1-6</sub>alkyl, C<sub>1-6</sub>alkoxy, C<sub>1-6</sub>alkoxyC<sub>1-2</sub>alkyl,  
 30 C<sub>1-6</sub>alkoxycarbonylC<sub>0-2</sub>alkyl, C<sub>1-6</sub>alkanoylC<sub>0-2</sub>alkyl, C<sub>1-6</sub>alkanoyloxyC<sub>0-2</sub>alkyl, C<sub>2-6</sub>alkenyl, C<sub>1-3</sub>perfluoroalkyl-, C<sub>1-3</sub>perfluoroalkoxy, aryl, arylC<sub>1-6</sub>alkyl, heterocyclyl, heterocyclylC<sub>1-6</sub>alkyl, N-C<sub>1-4</sub>alkylaminoC<sub>0-2</sub>alkyl, N, N-di-C<sub>1-4</sub>alkylaminoC<sub>0-2</sub>alkyl, N-C<sub>1-4</sub>alkylcarbamoylC<sub>0-2</sub>alkyl, N, N-di-C<sub>1-4</sub>alkylaminocarbamoylC<sub>0-2</sub>alkyl,

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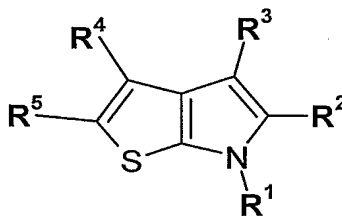
- N-C<sub>1-6</sub>alkylaminocarbonylC<sub>0-2</sub>alkyl, N, N-C<sub>1-6</sub>alkylaminocarbonylC<sub>0-2</sub>alkyl, C<sub>1-6</sub>alkyl-S(O)<sub>n</sub>-aminoC<sub>0-2</sub>alkyl-, aryl-S(O)<sub>n</sub>-aminoC<sub>0-2</sub>alkyl-, C<sub>1-3</sub>perfluoroalkyl-S(O)<sub>n</sub>-aminoC<sub>0-2</sub>alkyl-; C<sub>1-6</sub>alkylamino-S(O)<sub>n</sub>-C<sub>0-2</sub>alkyl-, arylamino-S(O)<sub>n</sub>-C<sub>0-2</sub>alkyl-, C<sub>1-3</sub>perfluoroalkylamino-S(O)<sub>n</sub>-C<sub>0-2</sub>alkyl-,
- 5 C<sub>1-6</sub>alkanoylamino-S(O)<sub>n</sub>-C<sub>0-2</sub>alkyl-; arylcarbonylamino-S(O)<sub>n</sub>-C<sub>0-2</sub>alkyl-, C<sub>1-6</sub>alkyl-S(O)<sub>n</sub>-C<sub>0-2</sub>alkyl-, aryl-S(O)<sub>n</sub>-C<sub>0-2</sub>alkyl-, C<sub>1-3</sub>perfluoroalkyl- or C<sub>1-3</sub>perfluoroalkoxyC<sub>0-2</sub>alkyl; wherein an amino group within R<sup>12</sup> is optionally substituted by C<sub>1-4</sub>alkyl.

- For instance, R<sup>12</sup> may be selected from hydroxy, hydroxyC<sub>1-6</sub>alkyl such as hydroxy methyl
- 10 or hydroxyethyl, oxo, cyano, cyanoC<sub>1-6</sub>alkyl such as cyanomethyl or cyanoethyl, nitro, carboxyl, C<sub>1-6</sub>alkyl such as methyl, ethyl or propyl, C<sub>1-6</sub>alkoxy such as methoxy or ethoxy, C<sub>1-6</sub>alkoxyC<sub>1-2</sub>alkyl such as methoxymethoxy, ethoxymethoxy, ethoxyethoxy or methoxyethoxy, C<sub>1-6</sub>alkoxycarbonylC<sub>0-2</sub>alkyl such as methoxycarbonyl or ethoxycarbonyl, C<sub>1-6</sub>alkanoylC<sub>0-2</sub>alkyl such as acetyl, C<sub>1-3</sub>perfluoroalkyl- such as trifluoromethyl,
- 15 C<sub>1-3</sub>perfluoroalkoxy such as trifluoromethoxy, aryl such as phenyl, arylC<sub>1-6</sub>alkyl such as benzyl, N-C<sub>1-4</sub>alkylaminoC<sub>0-2</sub>alkyl such as methylamino, N, N-di-C<sub>1-4</sub>alkylaminoC<sub>0-2</sub>alkyl such as di-methylamino, N-C<sub>1-4</sub>alkylcarbamoylC<sub>0-2</sub>alkyl, such as methylcarbamoyl, or N, N-di-C<sub>1-4</sub>alkylaminocarbamoylC<sub>0-2</sub>alkyl such as dimethylcarbamoyl.

Specific examples of R<sup>12</sup> groups include hydroxy, halo such as chloro, cyano, or nitro.

- 20 Other examples of R<sup>12</sup> are C<sub>1-6</sub>alkyl such as methyl, ethyl or propyl, aryl or aryl substituted by methyl, such as 4-phenylmethyl.

According to a further aspect of the invention there is provided a compound of Formula (Ia)

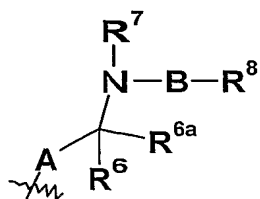


Formula (Ia)

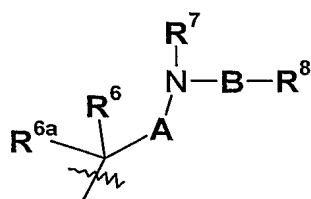
wherein:

R<sup>3</sup> is selected from a group of Formula (IIa) or Formula (IIb):

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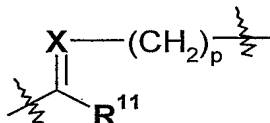


Formula (IIa)



Formula (IIb)

**B** is a group of Formula (IV)



Formula (IV)

5

and **A**, **R**<sup>1</sup>, **R**<sup>2</sup>, **R**<sup>4</sup>, **R**<sup>5</sup>, **R**<sup>6</sup>, **R**<sup>6a</sup>, **R**<sup>7</sup>, **R**<sup>8</sup>, and **R**<sup>11</sup> are as defined above for a compound of Formula (I)

or a salt, solvate or pro-drug thereof.

According to a further aspect of the invention there is provided a compound of

10 Formula (Ia) wherein:

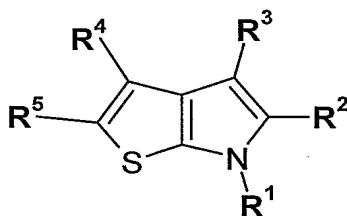
**X** is N;

**R**<sup>8</sup> is -C(O)O-**R**<sup>b</sup>, wherein **R**<sup>b</sup> is as defined above;

or a salt, solvate or pro-drug thereof.

According to a further aspect of the invention there is provided a compound of

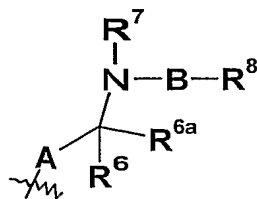
15 Formula (Ib)



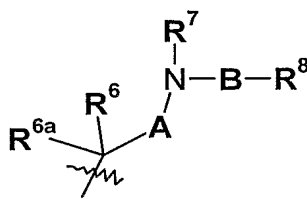
Formula (Ib)

wherein:

**R**<sup>3</sup> is selected from a group of Formula (IIa) or Formula (IIb):



Formula (IIa)

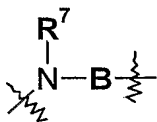


Formula (IIb)

20

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wherein

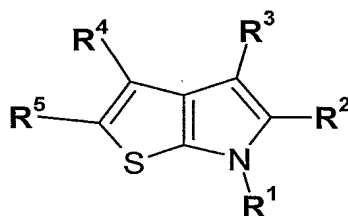


the group together forms an optionally substituted heterocyclic ring containing 4-7 carbons atoms, wherein the optional substituents are selected from 1 or 2 substituents independently selected from  $R^{12}$  and  $R^{13}$ ;

5 and A, B,  $R^1$ ,  $R^2$ ,  $R^4$ ,  $R^5$ ,  $R^6$ ,  $R^{6a}$ ,  $R^8$ ,  $R^{12}$  and  $R^{13}$  are as defined above for a compound of Formula (I)

or a salt, solvate or pro-drug thereof.

According to a further aspect of the invention there is provided a compound of Formula (Ic)

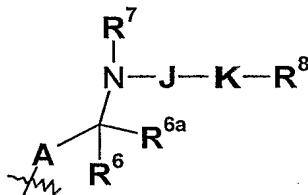


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Formula (Ic)

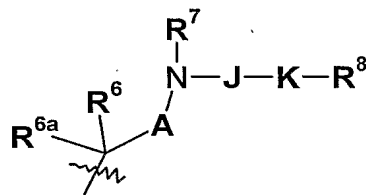
wherein:

$R^3$  is selected from a group of Formula (IIc) or Formula (IId):



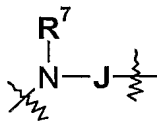
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Formula (IIc)



Formula (IId)

wherein



the group together forms an optionally substituted heterocyclic ring containing 4-7 carbons atoms, wherein the optional substituents are selected from 1 or 2 substituents independently selected from  $R^{12}$  and  $R^{13}$ ;

20 and A, J,  $R^1$ ,  $R^2$ ,  $R^4$ ,  $R^5$ ,  $R^6$ ,  $R^{6a}$ ,  $R^8$ , and  $R^{12}$  and  $R^{13}$  are as defined above for a compound of Formula (I)

or a salt, solvate or pro-drug thereof.

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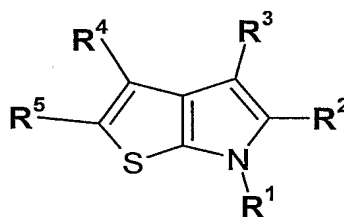
According to a further aspect of the invention there is provided a compound of Formula (Ic), wherein:

**K** is  $-(CH_2)_{s1}-C(O)-(CH_2)_{s2}-$  or  $-(CH_2)_{s1}-$ ;

**R<sup>8</sup>** is selected from: C<sub>3-7</sub>cycloalkyl, aryl or heterocyclyl each of which is optionally substituted by one or substituents independently selected from **R<sup>12</sup>** or **R<sup>13</sup>**; and **s1** and **s2** are as defined above;

or a salt, solvate or pro-drug thereof.

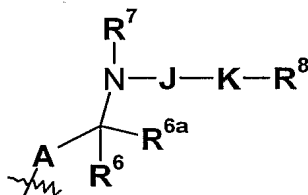
According to a further aspect of the invention there is provided a compound of Formula (Id)



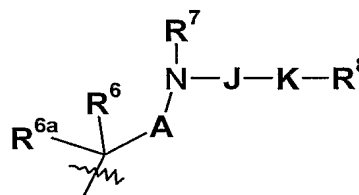
Formula (Id)

wherein:

**R<sup>3</sup>** is selected from a group of Formula (IIc) or Formula (IId):



Formula (IIc)



Formula (IId)

wherein

**J** is a group of the formula:  $-(CH_2)_s-L-(CH_2)_s-$  or

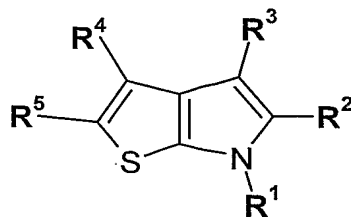
$-(CH_2)_s-C(O)-(CH_2)_s-L-(CH_2)_s-$  wherein when **s** is greater than 0, the alkylene group is optionally substituted by 1 to 2 group selected from **R<sup>12</sup>**,

and **A**, **K**, **L**, **R<sup>1</sup>**, **R<sup>2</sup>**, **R<sup>4</sup>**, **R<sup>5</sup>**, **R<sup>6</sup>**, **R<sup>6a</sup>**, **R<sup>8</sup>**, and **R<sup>12</sup>** are as defined above for a compound of Formula (I)

or a salt, solvate or pro-drug thereof.

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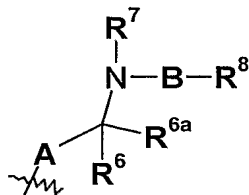
According to a further aspect of the invention there is provided a compound of Formula (Ie)



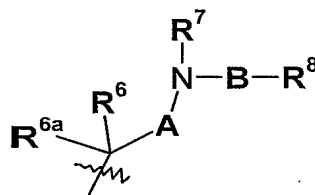
Formula (Ie)

5 wherein:

$R^3$  is selected from a group of Formula (IIa) or Formula (IIb):



Formula (IIa)



Formula (IIb)

$B$  is optionally substituted  $C_{1-6}$ alkylene, wherein the optional substituents are  
10 independently selected from  $R^{12}$ ;

$R^7$  is selected from: hydrogen or  $C_{1-6}$ alkyl;

$R^8$  is selected from:  $C_{3-7}$ cycloalkyl, aryl or heterocyclyl each of which is optionally  
substituted by one or substituents independently selected from  $R^{12}$  or  $R^{13}$ ;

and  $A$ ,  $R^1$ ,  $R^2$ ,  $R^4$ ,  $R^5$ ,  $R^6$ ,  $R^{6a}$  and  $R^{11}$  are as defined above for a compound of Formula (I);

15 or a salt, solvate or pro-drug thereof.

According to a further aspect of the invention there is provided a compound of  
Formula (Ie)

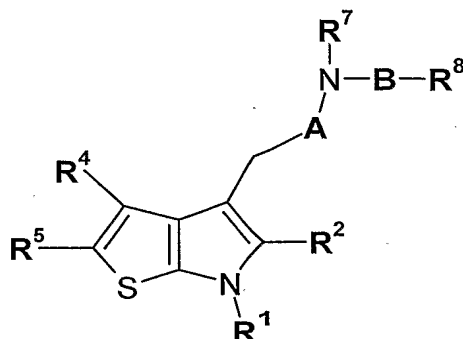
wherein

$R^8$  is selected from: aryl optionally substituted by one or substituents independently  
20 selected from  $R^{12}$  or  $R^{13}$ , preferably substituted  $R^{12}$ ;

or a salt, solvate or pro-drug thereof.

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A further preferred group of compounds of the invention comprises a compound of Formula (If):

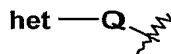


Formula (If)

- 5 wherein **R<sup>1</sup>**, **R<sup>2</sup>**, **R<sup>5</sup>**, **R<sup>7</sup>**, **R<sup>8</sup>**, **A**, and **B** are as defined above or salt, solvate or pro-drug thereof.

A further preferred group of compounds of the invention comprises a compound of Formula (Ia), (Ib), (Ic), (Id), (Ie) or (If), wherein:

**R<sup>5</sup>** is a group of the formula



10

wherein:

**het** is selected from: oxadiazolyl, thienyl, furanyl, thiazolyl, thiadiazolyl, triazolyl, pyrazolyl, imidazolyl, oxazolyl, isoxazolyl, pyridyl, pyrazinyl, pyridazinyl and pyrimidinyl, each of which is optionally substituted by from 1 to 2 groups selected from **R<sup>12</sup>**;

15

wherein **het** is preferably selected from: oxadiazolyl, oxazolyl, triazolyl, imidazolyl, pyrazinyl and pyrimidinyl; and

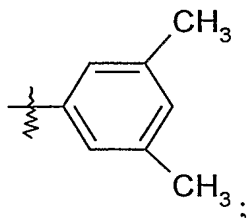
**Q** is selected from a direct bond or **-C(R<sup>15</sup>R<sup>15a</sup>)-** and **R<sup>15</sup>** and **R<sup>15a</sup>** are both methyl

20 or salt, solvate or pro-drug thereof.

A further preferred group of compounds of the invention comprises a compound of Formula (Ia), (Ib), (Ic), (Id), (Ie) or (If), wherein:

**R<sup>2</sup>** represents

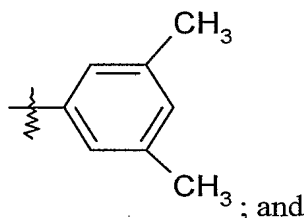
- 31 -



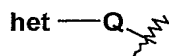
or salt, solvate or pro-drug thereof.

A further preferred group of compounds of the invention comprises a compound of Formula (Ia), (Ib), (Ic), (Id), (Ie) or (If), wherein:

5  $R^2$  represents



$R^5$  is a group of the formula



wherein:

10 **het** is selected from: oxadiazolyl, thienyl, furanyl, thiazolyl, thiadiazolyl, triazolyl, pyrazolyl, imidazolyl, oxazolyl, isoxazolyl, pyridyl, pyrazinyl, pyridazinyl and pyrimidinyl, each of which is optionally substituted by from 1 to 2 groups selected from  $R^{12}$ ;

wherein **het** is preferably selected from: oxadiazolyl, oxazolyl, triazolyl, imidazolyl, pyrazinyl and pyrimidinyl;

15 and

**Q** is selected from a direct bond or  $-C(R^{15}R^{15a})-$  and  $R^{15}$  and  $R^{15a}$  are both methyl or salt or salt, solvate or pro-drug thereof.

According to a further aspect of the invention there is provided a compound of Formula (I), or salt, solvate or pro-drug thereof, wherein  $R^3$  is selected from a group of Formula (IIc) or Formula (IId) and  $R^1$ ,  $R^2$ ,  $R^4$  and  $R^5$  are as defined above.

According to a further aspect of the invention there is provided a compound of Formula (I), or salt, solvate or pro-drug thereof, wherein  $R^3$  is selected from a group of Formula (IIa) or Formula (IIc) and  $R^1$ ,  $R^2$ ,  $R^4$  and  $R^5$  are as defined above.



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According to a further aspect of the invention there is provided a compound of Formula (I), or salt, solvate or pro-drug thereof, wherein  $R^3$  is selected from a group of Formula (IIb) and Formula (IId) and  $R^1$ ,  $R^2$ ,  $R^4$  and  $R^5$  are as defined above.

Examples of compounds falling with the scope of the invention include

- 5 2-[1-(5-butyl-1,3,4-oxadiazol-2-yl)-1-methylethyl]-5-(3,5-dimethylphenyl)-4-{2-[4-(2-oxo-2-pyrrolidin-1-ylethyl)piperazin-1-yl]ethyl}-6*H*-thieno[2,3-*b*]pyrrole;
- 5-(3,5-dimethylphenyl)-2-[1-methyl-1-(5-propyl-1,3,4-oxadiazol-2-yl)ethyl]-4-{2-[4-(2-oxo-2-pyrrolidin-1-ylethyl)piperazin-1-yl]ethyl}-6*H*-thieno[2,3-*b*]pyrrole;
- 5-(3,5-dimethylphenyl)-2-[1-(5-ethyl-1,3,4-oxadiazol-2-yl)-1-methylethyl]-4-{2-[4-(2-oxo-2-pyrrolidin-1-ylethyl)piperazin-1-yl]ethyl}-6*H*-thieno[2,3-*b*]pyrrole; and
- 10 5-(3,5-dimethylphenyl)-2-[1-methyl-1-(5-methyl-1,3,4-oxadiazol-2-yl)ethyl]-4-{2-[4-(2-oxo-2-pyrrolidin-1-ylethyl)piperazin-1-yl]ethyl}-6*H*-thieno[2,3-*b*]pyrrole;
- 5-(3,5-dimethylphenyl)-2-[1-methyl-1-(5-phenyl-1,3,4-oxadiazol-2-yl)ethyl]-4-{2-[4-(2-oxo-2-pyrrolidin-1-ylethyl)piperazin-1-yl]ethyl}-6*H*-thieno[2,3-*b*]pyrrole
- 15 5-(3,5-dimethylphenyl)-2-[1-methyl-1-(5-methyl-4*H*-1,2,4-triazol-3-yl)ethyl]-4-{2-[4-(2-oxo-2-pyrrolidin-1-ylethyl)piperazin-1-yl]ethyl}-6*H*-thieno[2,3-*b*]pyrrole
- 5-(3,5-dimethylphenyl)-2-{1-methyl-1-[3-(4-methylphenyl)-1,2,4-oxadiazol-5-yl]ethyl}-4-{2-[4-(2-oxo-2-pyrrolidin-1-ylethyl)piperazin-1-yl]ethyl}-6*H*-thieno[2,3-*b*]pyrrole
- (3*S*)-1-{[1-(2-{5-(3,5-dimethylphenyl)-2-[1-(5-ethyl-1,3,4-oxadiazol-2-yl)-1-methylethyl]-
- 20 6*H*-thieno[2,3-*b*]pyrrol-4-yl]ethyl)piperidin-4-yl]carbonyl}piperidin-3-ol
- 5-(3,5-dimethylphenyl)-2-[1-(5-ethyl-1,3,4-oxadiazol-2-yl)-1-methylethyl]-4-{2-[4-(morpholin-4-ylcarbonyl)piperidin-1-yl]ethyl}-6*H*-thieno[2,3-*b*]pyrrole
- 5-(3,5-dimethylphenyl)-2-[1-(3-isopropyl-1*H*-1,2,4-triazol-5-yl)-1-methylethyl]-4-{2-[4-(morpholin-4-ylcarbonyl)piperidin-1-yl]ethyl}-6*H*-thieno[2,3-*b*]pyrrole
- 25 or a salt, pro-drug or solvate thereof.

A preferred group of compounds according to the present invention are wherein the compound is selected from:

- 2-[1-(5-butyl-1,3,4-oxadiazol-2-yl)-1-methylethyl]-5-(3,5-dimethylphenyl)-4-{2-[4-(2-oxo-2-pyrrolidin-1-ylethyl)piperazin-1-yl]ethyl}-6*H*-thieno[2,3-*b*]pyrrole;
- 30 5-(3,5-dimethylphenyl)-2-[1-methyl-1-(5-propyl-1,3,4-oxadiazol-2-yl)ethyl]-4-{2-[4-(2-oxo-2-pyrrolidin-1-ylethyl)piperazin-1-yl]ethyl}-6*H*-thieno[2,3-*b*]pyrrole;
- 5-(3,5-dimethylphenyl)-2-[1-(5-ethyl-1,3,4-oxadiazol-2-yl)-1-methylethyl]-4-{2-[4-(2-oxo-2-pyrrolidin-1-ylethyl)piperazin-1-yl]ethyl}-6*H*-thieno[2,3-*b*]pyrrole; and

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5-(3,5-dimethylphenyl)-2-[1-methyl-1-(5-methyl-1,3,4-oxadiazol-2-yl)ethyl]-4-{2-[4-(2-oxo-2-pyrrolidin-1-ylethyl)piperazin-1-yl]ethyl}-6*H*-thieno[2,3-*b*]pyrrole;

or a salt, pro-drug or solvate thereof.

The compounds of Formula (I) may be administered in the form of a pro-drug which is broken down in the human or animal body to give a compound of the Formula (I). Examples of pro-drugs include in-vivo hydrolysable esters of a compound of the Formula (I).

Various forms of pro-drugs are known in the art. For examples of such pro-drug derivatives, see:

- a) Design of Prodrugs, edited by H. Bundgaard, (Elsevier, 1985) and Methods in Enzymology, Vol. 42, p. 309-396, edited by K. Widder, et al. (Academic Press, 1985);
- b) A Textbook of Drug Design and Development, edited by Krogsgaard-Larsen and H. Bundgaard, Chapter 5 "Design and Application of Prodrugs", by H. Bundgaard p. 113-191 (1991);
- c) H. Bundgaard, Advanced Drug Delivery Reviews, 8, 1-38 (1992);
- d) H. Bundgaard, et al., Journal of Pharmaceutical Sciences, 77, 285 (1988); and
- e) N. Kakeya, et al., Chem Pharm Bull, 32, 692 (1984).

An in-vivo hydrolysable ester of a compound of the Formula (I) containing a carboxy or a hydroxy group is, for example, a pharmaceutically-acceptable ester which is hydrolysed in the human or animal body to produce the parent acid or alcohol. Suitable pharmaceutically-acceptable esters for carboxy include C<sub>1-6</sub>alkoxymethyl esters for example methoxymethyl, C<sub>1-6</sub>alkanoyloxymethyl esters for example pivaloyloxymethyl, phthalidyl esters, C<sub>3-8</sub>cycloalkoxycarbonyloxyC<sub>1-6</sub>alkyl esters for example 1-cyclohexylcarbonyloxyethyl; 1,3-dioxolen-2-onylmethyl esters, for example 5-methyl-1,3-dioxolen-2-onylmethyl; and C<sub>1-6</sub>alkoxycarbonyloxyethyl esters.

An in-vivo hydrolysable ester of a compound of the Formula (I) containing a hydroxy group includes inorganic esters such as phosphate esters (including phosphoramidic cyclic esters) and  $\alpha$ -acyloxyalkyl ethers and related compounds which as a result of the in-vivo hydrolysis of the ester breakdown to give the parent hydroxy group/s. Examples of  $\alpha$ -acyloxyalkyl ethers include acetoxymethoxy and 2,2-dimethylpropionyloxy-methoxy. A selection of in-vivo hydrolysable ester forming groups for hydroxy include alkanoyl, benzoyl, phenylacetyl and substituted benzoyl and phenylacetyl, alkoxycarbonyl (to give alkyl carbonate esters), dialkylcarbamoyl and N-(dialkylaminoethyl)-N-alkylcarbamoyl (to

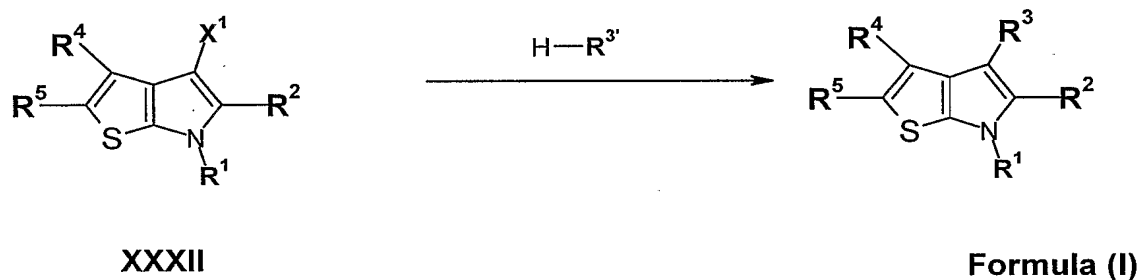
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give carbamates), dialkylaminoacetyl and carboxyacetyl.

A suitable pharmaceutically-acceptable salt of a compound of the invention is, for example, an acid-addition salt of a compound of the invention which is sufficiently basic, for example, an acid-addition salt with, for example, an inorganic or organic acid, for example hydrochloric, hydrobromic, sulphuric, phosphoric, trifluoroacetic, citric or maleic acid. In addition a suitable pharmaceutically-acceptable salt of a compound of the invention which is sufficiently acidic is an alkali metal salt, for example a sodium or potassium salt, an alkaline earth metal salt, for example a calcium or magnesium salt, an ammonium salt or a salt with an organic base which affords a physiologically-acceptable cation, for example a salt with methylamine, dimethylamine, trimethylamine, piperidine, morpholine or tris-(2-hydroxyethyl)amine.

The compounds of Formula (I) can be prepared by a process comprising a step selected from (a) to (g) as follows, these processes are provided as a further feature of the invention:-

(a) Reaction of a compound of formula XXXII with a compound of formula  $H-R^{3'}$  to form a compound of Formula (I),



wherein  $X^1$  is selected from:

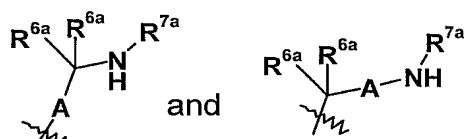
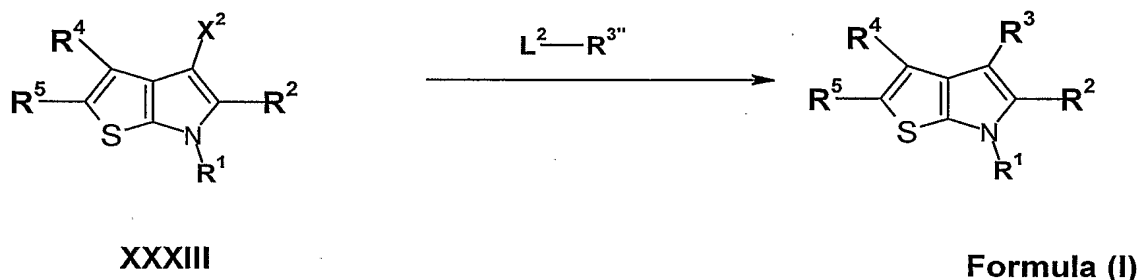
and  $L^1$  is a displaceable group;

$H-R^{3'}$  is selected from:

;

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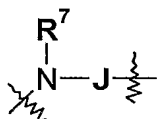
- (b) Reaction of a compound of formula XXXIII with a compound of formula  $L^2-R^{3''}$  to form a compound of Formula (I),



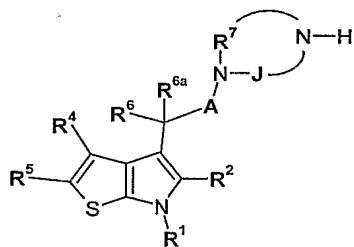
wherein  $X^2$  is selected from: ;  $L^2$  is a displaceable group and  $R^{7a}$  is selected from the definition of  $R^7$  or  $R^{22}$  above, and

$L^2-R^{3''}$  is selected from:  $L^2-B-R^8$  ,  $L^2-J-K-R^8$  and  $L^2-R^{21}$  ;

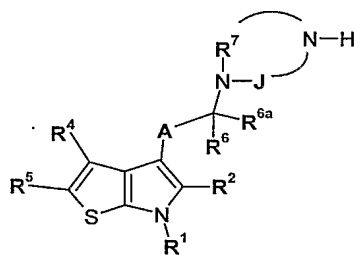
- (c) For compounds of Formula (I) wherein  $R^3$  is a group of Formula (IIa), (IIb), (IIc) or (IId) and  $R^7$  is other than part of a heterocyclic ring or hydrogen, reaction of a compound of Formula (I) wherein  $R^3$  is a group of Formula (IIa), (IIb), (IIc) or (IId) and  $R^7$  is hydrogen with a group of formula  $L^3-R^{7a}$ , wherein  $R^{7a}$  is as defined above for  $R^7$  with the exclusion of hydrogen and  $L^3$  is a displaceable group;
- (d) For compounds of Formula (I) wherein  $R^3$  is a group of Formula (IIc) or (IId) and



the group together forms an optionally substituted nitrogen-containing heterocyclic ring containing 4-7 carbons atoms, reaction of a compound of Formula XXXIVa or XXXIVb, with a compound of Formula  $L^6-K-R^8$ , wherein  $L^6$  is a displaceable group



XXXIVa

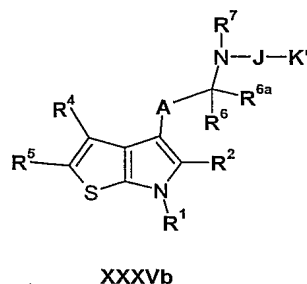
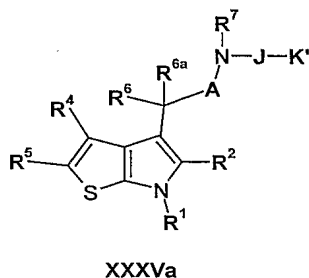


XXXIVb

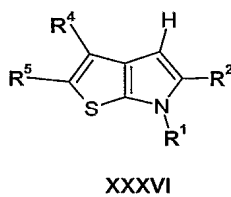
- (e) For compounds of Formula (I) wherein  $R^3$  is a group of Formula (IIc) or (IId), reaction of a compound of Formula XXXVa or XXXVb, with a compound of Formula  $L^7-K''-R^8$ ,

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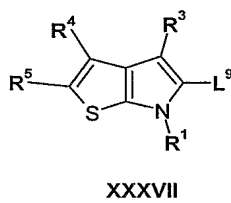
wherein  $L^7$  is a displaceable group, and wherein the groups  $K'$  and  $K''$  comprise groups which when reacted together form  $K$ ,



- (f) reaction of a compound of Formula XXXVI with an electrophilic compound of the formula  $L^8-R^3$ , wherein  $L^8$  is a displaceable group



- (g) reaction of a compound of Formula XXXVII with a compound of the formula  $L^{10}-R^2$ , wherein  $L^9$  is a leaving group and  $L^{10}$  is an activating group or  $L^9$  is an activating group and  $L^{10}$  is a leaving group



and thereafter if necessary:

- i) converting a compound of the Formula (I) into another compound of the Formula (I);
- ii) removing any protecting groups;
- iii) forming a salt, pro-drug or solvate.

Specific reaction conditions for the above reactions are as follows:

*Process a)* Compounds of formula XXXII and  $H-R^{3'}$  can be coupled together in the presence of an organic base (such as DIPEA [di-isopropylethylamine]) or an inorganic base (such as potassium carbonate) base, in a suitable solvent such as DMA or DMF, at a temperature from room temperature and 120°C. Suitable displaceable groups include: a halide, such as chloro, or a methane sulphonate or toluene sulphonate;

*Process b)* Compounds of XXXIII and  $L^2-R^{3'}$  can be coupled together in the presence of an organic base (such as DIPEA) or an inorganic base (such as potassium carbonate), in a

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suitable solvent such as DMA or DMF, at a temperature from room temperature to 120°C. Suitable displaceable groups include: a halide, such as chloro, or a methane sulphonate or toluene sulphonate,

alternatively if  $L^2$  is a hydroxy group then the  $L^2-R^{3''}$  can be reacted with a compound of formula XXXIII under Mitsunobu reaction conditions;

*Process c and d)* Reaction conditions to facilitate these reactions can be using

(i) alkylation reaction conditions or (ii) acylation reaction conditions: Examples of said conditions include:

(i) alkylation reaction conditions - the presence of an organic base (such as DIPEA) or an inorganic base (such as potassium carbonate), in a suitable solvent such as DMF, DMA, DCM, at a temperature from room temperature to 120°C. Suitable displaceable groups include: a halide, such as chloro, methane sulphonate or toluene sulphonate;

(ii) acylation reaction conditions - presence of organic base, such as triethylamine, temperature 0°C to 50-60°C in a suitable solvent such as DCM. Suitable displaceable groups include an acylchloride or an acid anhydride,

*Process e)* The skilled man would be familiar with a variety of reaction conditions and values for  $K'$  and  $K''$ , which when reacted together would form the group  $K$ , examples of said conditions and values for  $K'$  and  $K''$  include:

(i) For compounds of Formula (I) where  $K$  is  $-(CH_2)_{s1}-N(R^{14})C(O)-(CH_2)_{s2}-$  these can be prepared by reacting a compound where  $K'$  is  $-(CH_2)_{s1}-N(R^{14})H$  with a carboxylic acid for formula  $HOOC-(CH_2)_{s2}-R^8$  to form the amide. Coupling of amino groups with carboxylic acids are well known in the art and can be facilitated by a number of chemical reactions using an appropriate coupling reagent. For example a carbodiimide coupling reaction can be performed with EDCI in the presence of DMAP in a suitable solvent such as DCM, chloroform or DMF at room temperature;

(ii) For compounds of Formula (I) where  $K$  is  $-(CH_2)_{s1}-C(O)N(R^{14})-(CH_2)_{s2}-$  these can be prepared by reacting a compound where  $K'$  is  $-(CH_2)_{s1}-COOH$  with an amine of the  $HN(R^{14})-(CH_2)_{s2}-R^8$  to form the amide. Methodology is identical to processes described in (i) above in this section;

(iii) For compounds of Formula (I) where  $K$  is  $-(CH_2)_{s1}-N(R^{14})C(O)O-(CH_2)_{s2}-$  these can be prepared by reacting a compound where  $K'$  is  $-(CH_2)_{s1}-N(R^{14})H$  with a chloroformate of formula  $ClC(O)O-(CH_2)_{s2}-R^8$  in a suitable solvent, such as

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DCM or chloroform, in the presence of a base, such as *N*-methylmorpholine, pyridine or triethylamine, at a temperature between -10°C and 0°C;

(iv) *For compounds of Formula (I) where K is  $-(CH_2)_{s1}-OC(O)N(R^{14})-(CH_2)_{s2}-$*

these can be prepared by reacting a compound where **K'** is  $-(CH_2)_{s1}-OC(O)Cl$  with a compound of formula  $HN(R^{14})-(CH_2)_{s2}-R^8$ . Methodology is identical to processes described in (iii) above in this section;

(v) *For compounds of Formula (I) where K is  $-(CH_2)_{s1}-N(R^{14})S(O_2)-(CH_2)_{s2}-$*

these can be prepared by reacting a compound where **K'** is  $-(CH_2)_{s1}-N(R^{14})H$  with a sulphonyl chloride of formula  $ClS(O_2)-(CH_2)_{s2}-R^8$  in the presence of a base, such as triethylamine or pyridine, in a suitable solvent such as chloroform or DCM at a temperature between 0°C and room temperature;

(vi) *For compounds of Formula (I) where K is  $-(CH_2)_{s1}-S(O_2)N(R^{14})-(CH_2)_{s2}-$*

these can be prepared by reacting a compound where **K'** is  $-(CH_2)_{s1}-S(O_2)Cl$  with a compound of  $HN(R^{14})-(CH_2)_{s2}-R^8$ . Methodology is identical to processes described in (v) above in this section

(vii) *For compounds of Formula (I) where K is  $-(CH_2)_{s1}-N(R^{14})-(CH_2)_{s2}-$*

these can be prepared by reacting a compound where **K'** is  $-(CH_2)_{s1}-L^{11}$  with a compound of formula  $HN(R^{14})-(CH_2)_{s2}-R^8$ , wherein **L**<sup>11</sup> is a displaceable group. This reaction can be performed in the presence of an organic base (such as DIPEA) or an inorganic base (such as potassium carbonate), in a suitable solvent such as DMA or DMF, at a temperature from room temperature to 120°C. Suitable displaceable groups include: a halide, such as chloro, or a methane sulphonate or toluene sulphonate. Compounds can also be prepared by reacting a compound wherein **K'** is  $-(CH_2)_{s1}-N(R^{14})H$  with a compound of formula  $L^{11}-(CH_2)_{s2}-R^8$ , under identical conditions.

(viii) *For compounds of Formula (I) where K is  $-(CH_2)_{s1}-O-(CH_2)_{s2}-$*

these can be prepared by reacting a compound where **K'** is  $-(CH_2)_{s1}-OH$  with a compound of formula  $L^{12}-(CH_2)_{s2}-R^8$ , wherein **L**<sup>12</sup> is a displaceable group. This reaction can be performed in the presence of an organic base (such as potassium *t*-butoxide) or an inorganic base (such as sodium hydride), in a suitable solvent such as DMA or DMF, at a temperature from room temperature to 120°C.

Suitable displaceable groups include: a halide, such as bromo, or a methane sulphonate or toluene sulphonate. Compounds can also be prepared by reacting a

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compound wherein  $K'$  is  $-(CH_2)_{s1}-L^{12}$  with a compound of formula  $HO-(CH_2)_{s2}-R^8$ , under identical conditions.

(ix) *For compounds of Formula (I) where  $K$  is  $-(CH_2)_{s1}-C(O)-(CH_2)_{s2}-$*

these can be prepared by reacting a compound where  $K'$  is  $-(CH_2)_{s1}-C(O)-L^{13}$  with a Grignard reagent of formula  $BrMg(CH_2)_{s2}-R^8$ , wherein  $L^{13}$  is a

displaceable group. This reaction can be performed in a non-polar solvent such as THF or diethylether at a temperature between room temperature and the boiling point of the solvent. Suitable displaceable groups include: a halide, such as chloro, or an alkoxide. Compounds can also be prepared by reacting a compound wherein  $K'$  is  $-(CH_2)_{s1}-MgBr$  with a compound of formula  $L^{13}-C(O)-(CH_2)_{s2}-R^8$ , under identical conditions.

*Process f)* reaction of a compound of Formula XXXVI with a compound of the formula  $L^8-R^3$ , can be performed under Friedel Craft conditions, for example in the presence of diethylaluminium chloride in a suitable solvent, such as DCM, in an inert atmosphere such as nitrogen, at a temperature between room temperature and the boiling point of the solvent or under Mannich conditions, for example, formaldehyde and a primary or secondary amine in acetic acid, in an inert atmosphere such as nitrogen at a temperature between room temperature and 100°C.

*Process g)* reaction of a compound of Formula XXXVII with a compound of the formula  $L^{10}-R^2$ , wherein  $L^9$  is a leaving group and  $L^{10}$  is an activating group or  $L^9$  is an activating group and  $L^{10}$  is a leaving group, can be performed in an aprotic, polar solvent such as THF, using palladium chemistry under Suzuki or Stille conditions, at a temperature between 0 to 70°C.

It will be appreciated by those skilled in the art that in the processes of the present invention certain functional groups such as hydroxyl or amino groups in the starting reagents or intermediate compounds may need to be protected by protecting groups. Thus, the preparation of the compounds of Formula (I) may involve, at an appropriate stage, the addition and subsequent removal of one or more protecting groups.

The protection and de-protection of functional groups is described in 'Protective Groups in Organic Chemistry', edited by J.W.F. McOmie, Plenum Press (1973) and 'Protective Groups in Organic Synthesis', 2nd edition, T.W. Greene and P.G.M. Wuts, Wiley-Interscience (1991).



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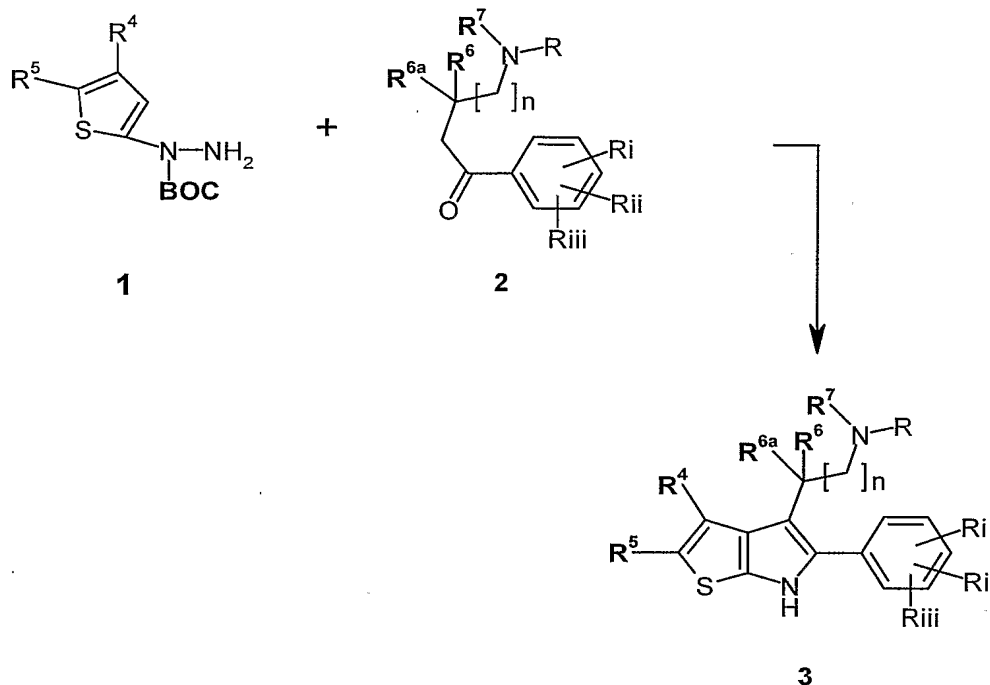
A suitable protecting group for an amino or alkylamino group is, for example, an acyl group, for example an alkanoyl group such as acetyl, an alkoxycarbonyl group, for example a methoxycarbonyl, ethoxycarbonyl or *tert*-butoxycarbonyl group, an arylmethoxycarbonyl group, for example benzyloxycarbonyl, or an aroyl group, for example benzoyl. The de-  
5 protection conditions for the above protecting groups necessarily vary with the choice of protecting group. Thus, for example, an acyl group such as an alkanoyl or alkoxycarbonyl group or an aroyl group may be removed for example, by hydrolysis with a suitable base such as an alkali metal hydroxide, for example lithium or sodium hydroxide. Alternatively an acyl group such as a *tert*-butoxycarbonyl group may be removed, for example, by treatment with a  
10 suitable acid as hydrochloric, sulphuric or phosphoric acid or trifluoroacetic acid and an arylmethoxycarbonyl group such as a benzyloxycarbonyl group may be removed, for example, by hydrogenation over a catalyst such as palladium-on-carbon, or by treatment with a Lewis acid for example boron tris(trifluoroacetate). A suitable alternative protecting group for a primary amino group is, for example, a phthaloyl group which may be removed by  
15 treatment with an alkylamine, for example dimethylaminopropylamine, or with hydrazine.

A suitable protecting group for a hydroxy group is, for example, an acyl group, for example an alkanoyl group such as acetyl, an aroyl group, for example benzoyl, or an arylmethyl group, for example benzyl. The de-protection conditions for the above protecting groups will necessarily vary with the choice of protecting group. Thus, for example, an acyl  
20 group such as an alkanoyl or an aroyl group may be removed, for example, by hydrolysis with a suitable base such as an alkali metal hydroxide, for example lithium or sodium hydroxide. Alternatively an arylmethyl group such as a benzyl group may be removed, for example, by hydrogenation over a catalyst such as palladium-on-carbon.

A suitable protecting group for a carboxy group is, for example, an esterifying group,  
25 for example a methyl or an ethyl group which may be removed, for example, by hydrolysis with a base such as sodium hydroxide, or for example a *tert*-butyl group which may be removed, for example, by treatment with an acid, for example an organic acid such as trifluoroacetic acid, or for example a benzyl group which may be removed, for example, by hydrogenation over a catalyst such as palladium-on-carbon.

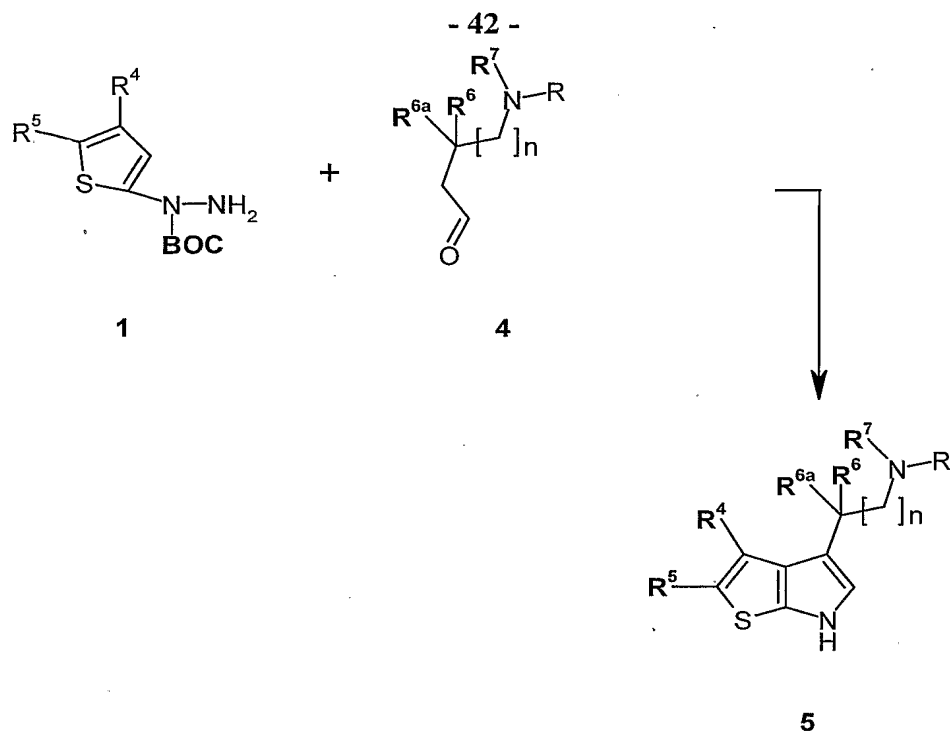
**EXPERIMENTAL****GENERAL REACTION SCHEMES**

In the following schemes wherein Ri, Rii and Riii represent optional substituents on the phenyl ring which are optionally protected as necessary and R represents a protecting group, group C has been depicted as substituted phenyl for illustration purposes only. Other definitions of C are also appropriate.



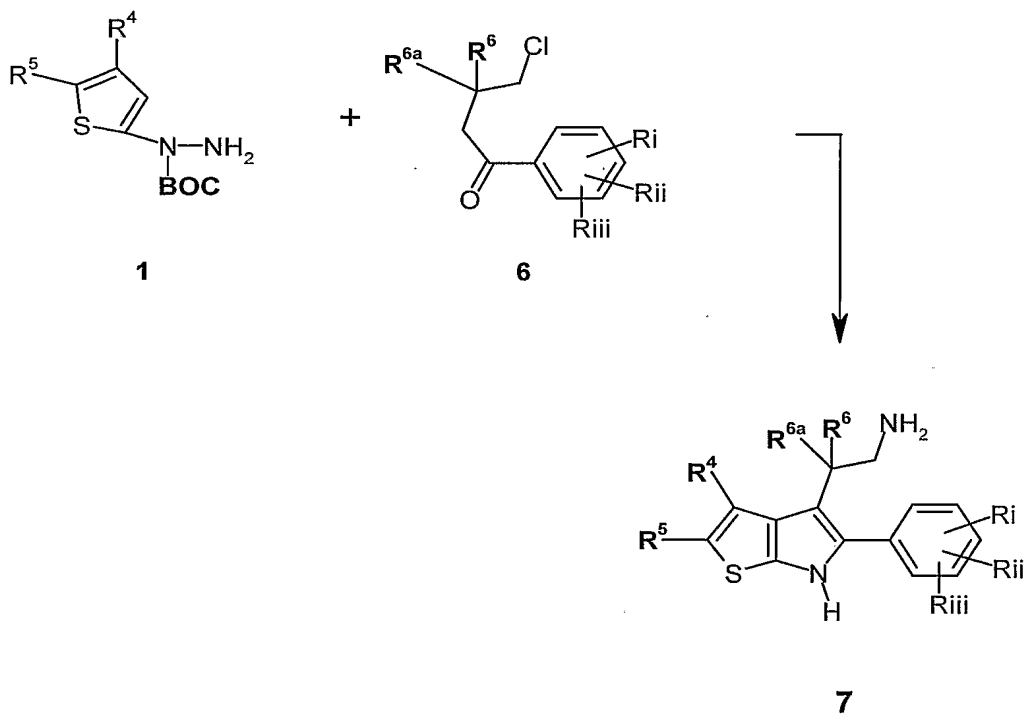
Scheme a

Thienopyrroles, such as 3 can be synthesised by the classic Fisher thienopyrrole synthesis reaction by the condensation of a hydrazine-HCl 1 and a ketone 2, bearing hydrogen atoms  $\alpha$  to the carbonyl (Scheme a). Treatment of these reactants in a suitable solvent, such as acetic acid, ethanol, *sec*-butanol, toluene, in the presence of an acid, such as sulphuric, hydrochloric, polyphosphoric and/or a Lewis acid, for example, boron trifluoride, zinc chloride, magnesium bromide, at elevated temperatures (for example 100 °C), gives the desired product. R represents a protecting group, eg *tert*-butylcarbamate or phthalimide.



Scheme b

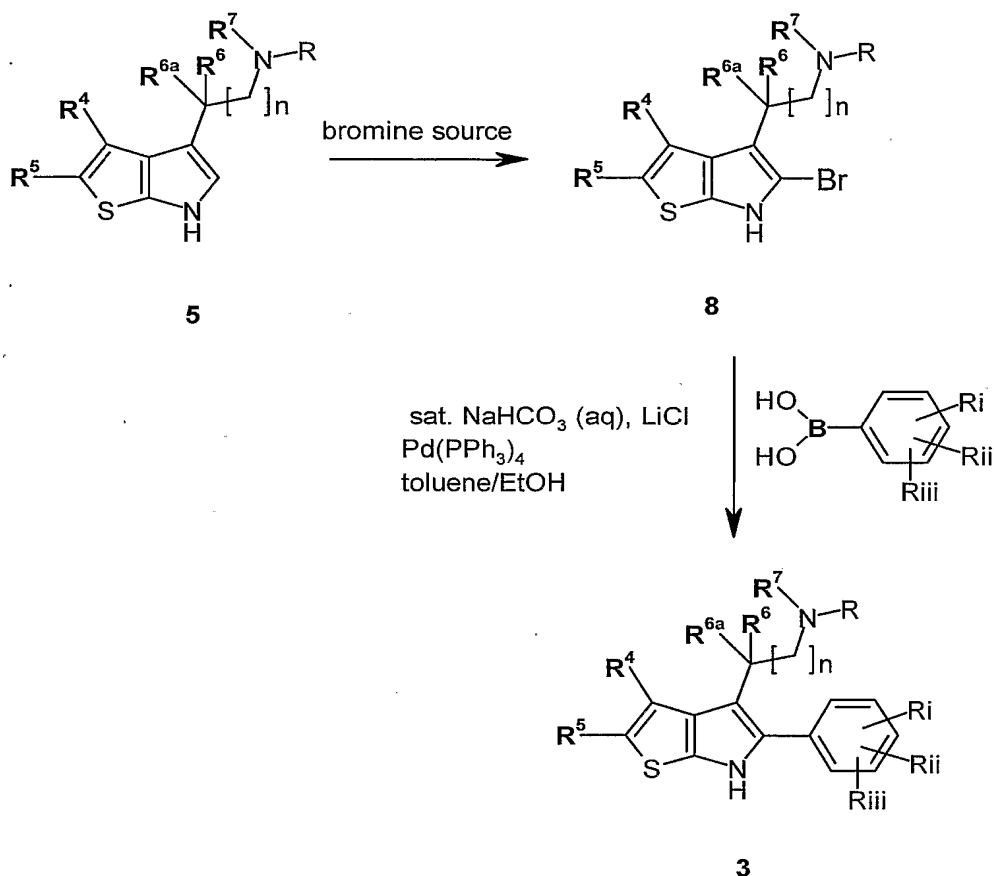
Thienopyrroles, such as represented in structure **5**, can also be made using aldehydes **4**, bearing hydrogen atoms  $\alpha$  to the carbonyl, by cyclization using the conditions above. In this case the substituent at the 2-position must be added later (see scheme d).



Scheme c

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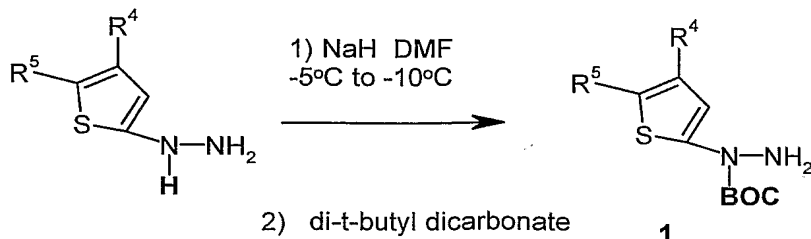
Thienopyrrole may also be synthesised utilising the Granburg reaction, wherein a hydrazine **1** is mixed with ketone **6**, bearing a chlorine atom  $\square$  to the carbonyl, and heated in a suitable solvent such as ethanol, *sec*-butanol, toluene at a temperature between 50 °C and 120 °C (Scheme c).



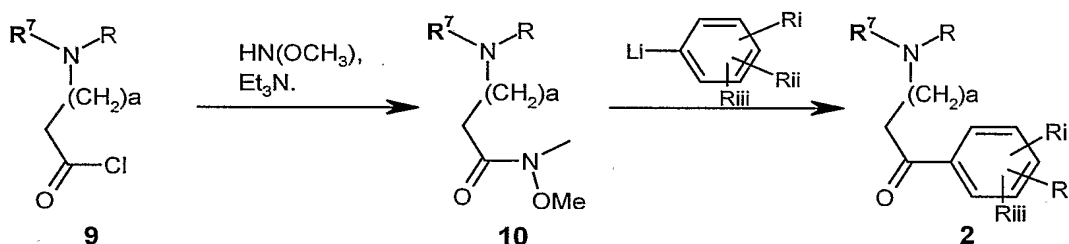
Scheme d

The thienopyrrole **5** can be treated with a 'bromine source', such as molecular bromide, pyridinium tribromide, pyrrolidone hydrobromide or polymer supported reagent equivalents, in an inert solvent such as chloroform, methylene chloride at -10 °C to 25 °C to yield the 2-bromo compound **8** (Scheme d). Reaction under Suzuki conditions with a palladium(0) catalyst, a weak base such as aqueous sodium carbonate or saturated sodium hydrogen carbonate and the like, and a substituted aryl boronic acid from commercial sources or prepared (as described in: Gronowitz, S.; Hornfeldt, A.-B.; Yang, Y.,-H *Chem. Sci.* **1986**, 26, 311-314), in an inert solvent such as toluene, benzene, dioxane, THF, DMF and the like, with heating between 25 °C and 100 °C, preferably 80 °C, for a period of 1-12 hours, to give the desired compound **3**.

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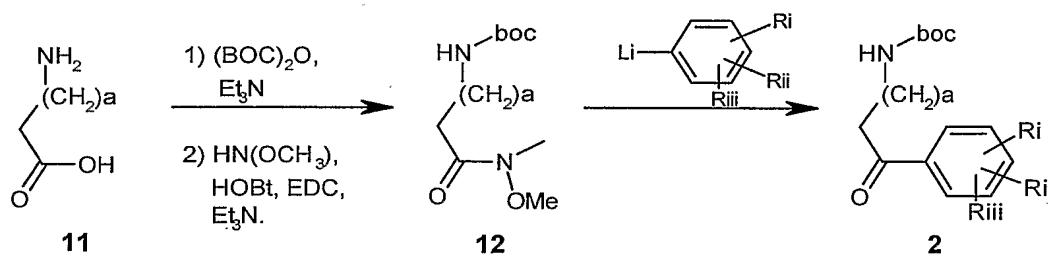


The thiophene **1** can be synthesised by reaction of a hydrazine under the preferred conditions of sodium hydride in DMF at a temperature between -10 °C and -5 °C, followed by reaction with di-*tert*-butyldicarbonate in THF under reflux.



Scheme e.

Substituted ketones **2** can be prepared, as outlined in Scheme e starting from appropriate acid chlorides such as **9**. Treatment of the acid chloride with *N,N*-dimethylhydroxylamine hydrochloride in the presence of an amine base such as triethylamine, and a suitable solvent such as methylene chloride at a temperature of -10 °C to 25 °C, yields the amide **10**. Further reaction with a substituted aryl organolithium (prepared essentially as described in Wakefield B, J.; *Organolithium Methods* Academic Press Limited, **1988**, pp. 27-29 and references therein) in an inert solvent such as tetrahydrofuran, diethyl ether, benzene, toluene or mixture thereof and the like, at a temperature between -100 °C and 0 °C then quenching of the reaction mixture with a mineral acid such as hydrochloric acid, yields the aryl ketone **2**.



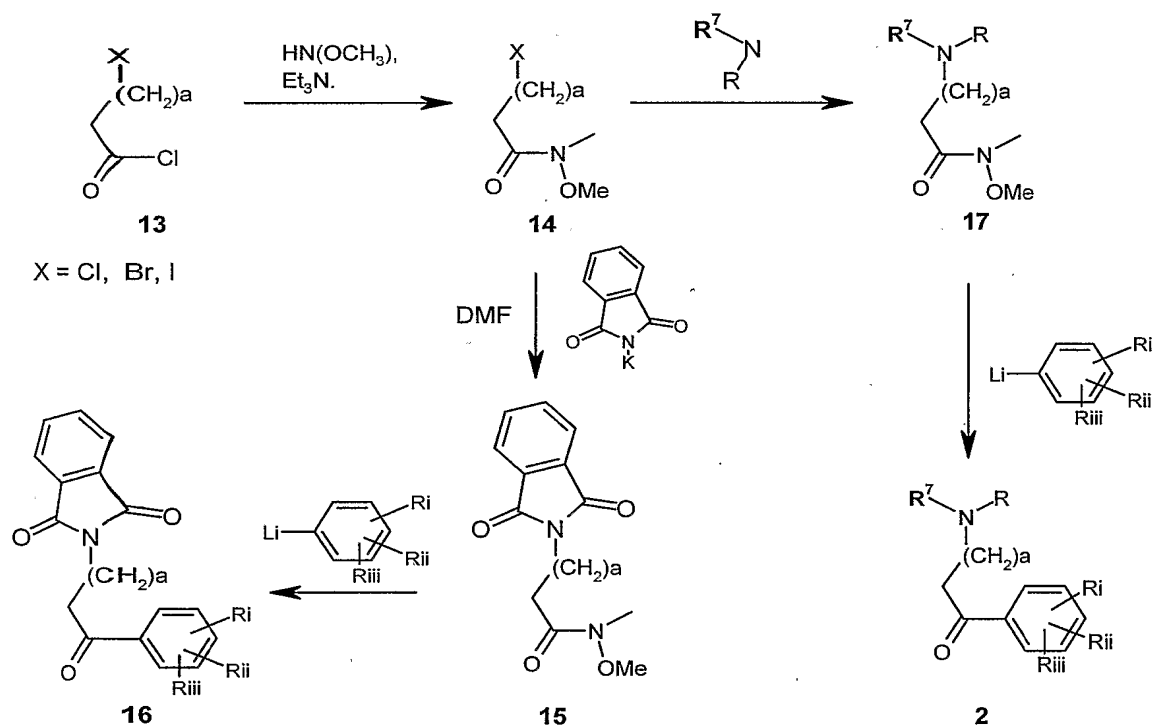
Scheme f.

Commencing with a readily available amino acid with a suitable chain length [a] **11**, the nitrogen atom can be brought in at the beginning of the synthesis by the route shown in

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Scheme f. Protection of the amine group of **11** with a *tert*-butylcarbamate group is achieved by condensation with di-*tert*-butyl di-carbonate in the presence of an amine base, for example triethylamine, in an inert solvent such as methylene chloride, chloroform, benzene, toluene, tetrahydrofuran and mixtures thereof and the like, at a temperature of -10 °C to 25 °C.

- 5 Coupling of the acid product with *N,N*-dimethylhydroxylamine in the presence of a coupling reagent **1**-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (EDC) or 1,3-dicyclohexylcarbodiimide (DCC) or the like, with or without 1-hydroxybenzotriazole (HOBt), and suitable amine base, such as triethylamine and the like, in an inert solvent such as methylene chloride, chloroform, dimethylformamide, or mixture thereof, at or near room
- 10 temperature for a period of 3 to 24 hours provided the corresponding coupled product **12**.
- Following the same route described above for scheme e, the aryl group can then be installed.

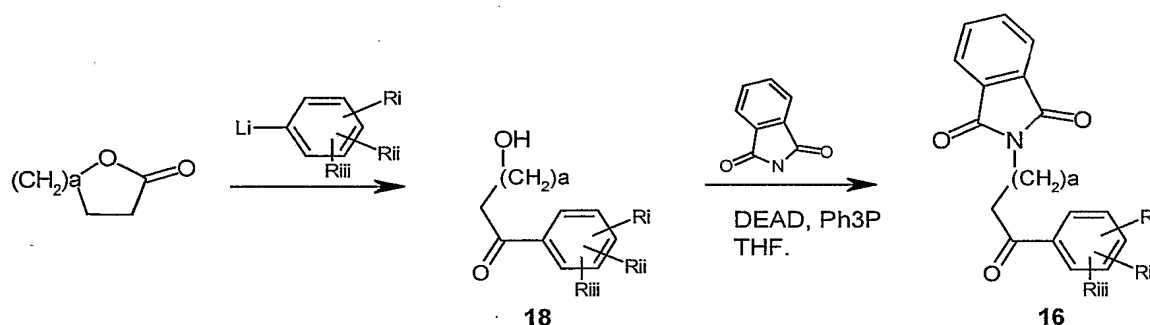


Scheme g.

- Scheme g illustrates another method for the synthesis of ketone such as **2** and **16**, where the nitrogen group is introduced at a latter stage. As above a Weinreb amide **14** can be synthesised from an acid chloride. Treatment with the required amine, in an inert solvent such as THF, toluene, water and the such like can displace the group X to give **17**. As above the aryl group can be introduced by displacement of the Weinreb amide with a suitable aryl lithium nucleophile. Alternatively the nitrogen atom can be introduced already protected as a phthalimide by displacement of the group X by potassium phthalimide, or similar salt thereof,
- 20

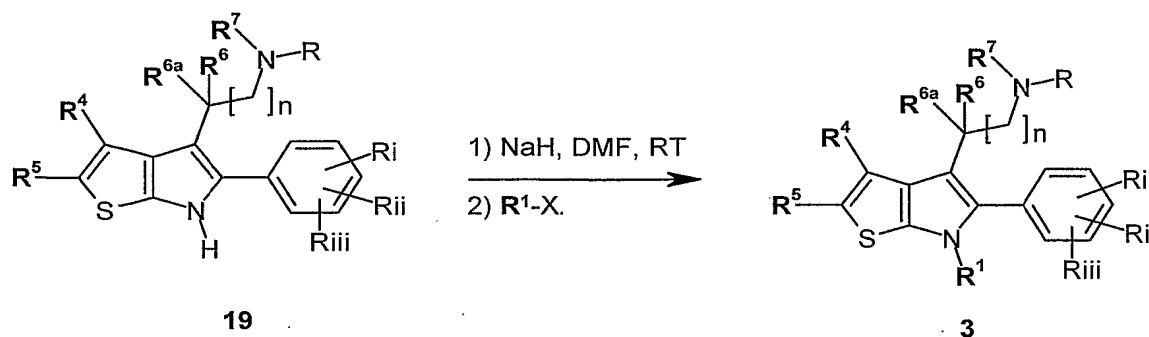
- 46 -

by heating in an inert polar solvent such as DMF, DMSO, THF, toluene with or without the presence of a catalyst such as tetrabutylammonium iodide and the such like, to yield the compound **15**. Again displacement of the Weinreb amide with an organolithium species completes the synthesis of ketone **16** suitable for cyclization under the Fischer condition 5 described above for thienopyrrole synthesis.



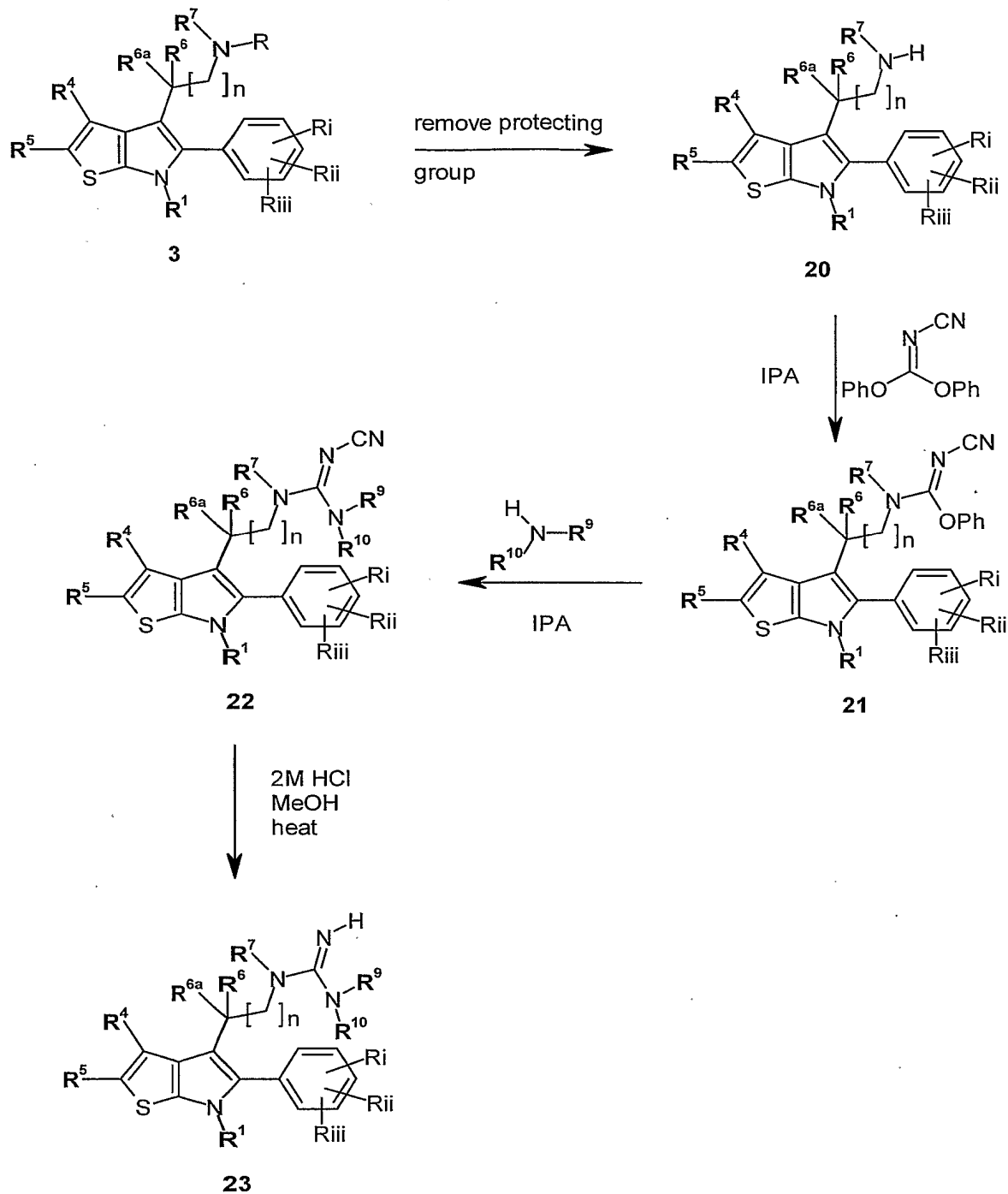
Scheme h.

An alternative approach to a phthalimide protected nitrogen ketone, such as **16**, can be taken by firstly treating a lactone, with an organolithium species as in the above schemes in a suitable solvent such as THF or ether at a low temperature of between  $-100^{\circ}\text{C}$  and  $-50^{\circ}\text{C}$  to yield a primary alcohol **18** (Scheme h). The hydroxyl function of **18** is replaced with a phthalimide group by a Mitsunobu reaction with an activating agent such as diethyldiazocarboxylate (DEAD), diisopropyldiazocarboxylate or the like with triphenylphosphine, tri-butylphosphine and the like, in an inert solvent such as benzene, toluene, tetrahydrofuran or mixtures thereof to give the desired ketone **16**.



If the group  $\text{R}^1$  was not present on the starting hydrazine before cyclization to form a thienopyrrole it may be added post cyclization by an alkylation reaction (**19**  $\rightarrow$  **3**). The thienopyrrole is de-protonated by a strong base, such as sodium hydride, *n*-butyl lithium, lithium diisopropylamine, sodium hydroxide, potassium *tert*-butoxide in a suitable inert solvent such as THF, DMF, DMSO and the such like, and an alkyl halide added and the mixture stirred at room temperature.

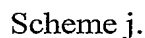
- 47 -



Scheme i

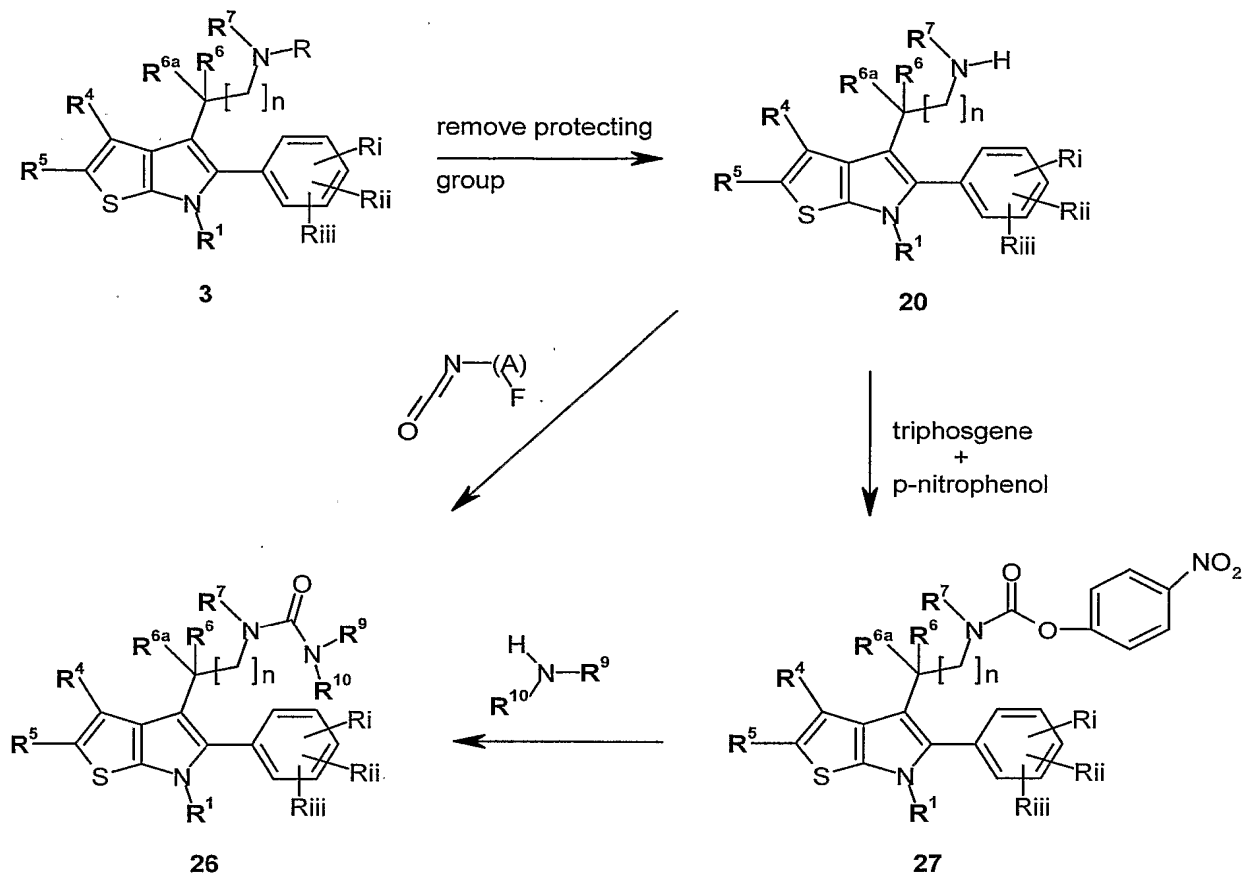
Depending on the route used above a thienopyrrole **20** suitable for conversion to a cyano-guanidine can be formed by removal of the protecting group, for example if a *tert*-butylcarbamate group was used then removal is accomplished using a strong acid, for example trifluoroacetic acid or hydrochloric acid in an inert solvent such as methylene chloride, chloroform, THF or dioxane at a temperature between  $-20\text{ }^{\circ}\text{C}$  and  $25\text{ }^{\circ}\text{C}$ . A





Similarly, reaction with 1,1'-bis(methylthio)-2-nitroethylene in an inert solvent such as methylene chloride, chloroform, benzene, tetrahydrofuran and the like, followed by condensation with an appropriately substituted amine in an inert organic solvent from the list above yields the nitroethyleneimidazo[1,2-*a*]pyridine **25** (Scheme j, **20**–**24**–**25**).

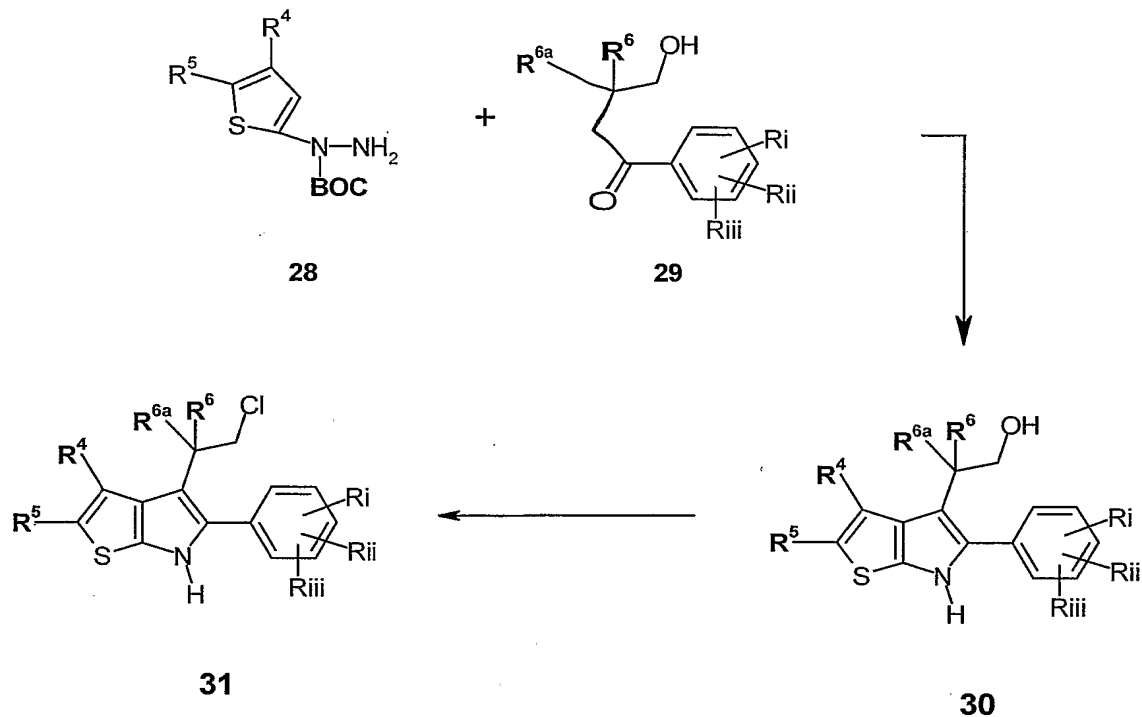
- 49 -



Scheme k.

Again in a similar fashion the suitable thienopyrrole **20**, derived from de-protection, can be converted to a urea by either direct treatment with an iso-cyanate in an inert solvent such as methylene chloride, chloroform or THF and the such like, or by a two step procedure of reaction with triphosgene (**20**→**27**) followed by addition of an amine (**27**→**26**), bearing the required substitution to yield **26**.

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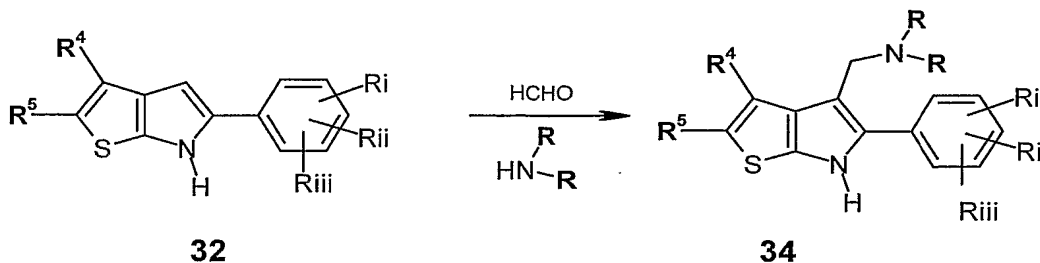


Scheme 1.

Chloro thieno-pyrrole intermediates, such as **31**, can be made as shown in Scheme 1.

**30** can be synthesized by the classic Fischer thieno-pyrrole synthesis reaction by the condensation of a hydrazine-HCl **28** and a ketone **29**, bearing hydrogen atoms  $\alpha$  to the carbonyl.

Treatment of these reactants in a suitable solvent, such as acetic acid, ethanol, *sec*-butanol, toluene, in the presence of an acid, such as sulphuric, hydrochloric, polyphosphoric and/or a Lewis acid, for example, boron trifluoride, zinc chloride, magnesium bromide, at elevated temperatures (for example 100 °C), gives the desired product. The chloro intermediate **31** can then be synthesized from **30** using, for example, either (i) sulphonyl chloride in methylene chloride at a temperature of about 0°C, or (ii) CCl<sub>4</sub> followed by triphenylphosphine in a solvent such as acetonitrile at a temperature of about 0°C. Thienopyrroles of the invention can then be prepared by displacement of chlorine atom using an appropriate side chain intermediate such as a substituted heterocyclic ring.



Scheme m.

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Thienopyrroles of Formula (I) wherein **A** is a direct bond and **R<sup>6</sup>** and **R<sup>6a</sup>** are both hydrogen can be prepared as shown in Scheme m. A thieno-pyrrole **32** can be reacted with formaldehyde and an amine, in a suitable solvent such as acetic acid/dioxan at a temperature of about 0°C to 25°C for between about 1 to 8 hours, form the thieno-pyrrole **34**.

5

### EXAMPLES

The invention will now be illustrated with the following non-limiting examples in which, unless otherwise stated:

(i) evaporations were carried out by rotary evaporation *in vacuo* and work-up  
10 procedures were carried out after removal of residual solids such as drying agents by filtration;

(ii) operations were carried out at room temperature, that is in the range 18-25°C and under an atmosphere of an inert gas such as argon or nitrogen;

(iii) yields are given for illustration only and are not necessarily the maximum  
15 attainable;

(iv) the structures of the end-products of the Formula (I) were confirmed by nuclear (generally proton) magnetic resonance (NMR) and mass spectral techniques; proton magnetic resonance chemical shift values were measured on the delta scale and peak multiplicities are shown as follows: s, singlet; d, doublet; t, triplet; m, multiplet; br, broad; q, quartet, quin,  
20 quintet;

(v) intermediates were not generally fully characterised and purity was assessed by thin layer chromatography (TLC), high-performance liquid chromatography (HPLC), infra-red (IR) or NMR analysis;

(vi) chromatography was performed on silica (Merck Keisegel: Art.9385);

25 (vii) isolate™ refers to silica (SiO<sub>2</sub>) based columns with irregular particles with an average size of 50µm with nominal 60 Å porosity [Source: Jones Chromatography, Ltd., Glamorgan, Wales, United Kingdom].

### Abbreviations

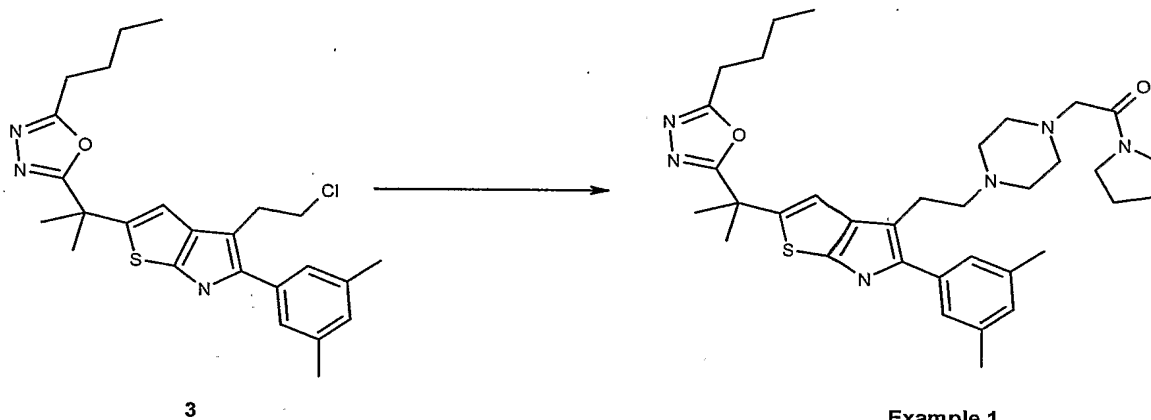
30 DCC	1,3-dicyclohexylcarbodiimide
DCM	dichloromethane
DEAD	diethylazodicarboxylate
DIPEA	di-isopropylethylamine

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DMA	dimethylacetamide
DMSO	dimethyl sulphoxide
DMAP	4-dimethylaminopyridine
DMF	dimethylformamide
5 EDCI	1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride
HOBt	1-hydroxybenzotriazole
THF	tetrahydrofuran

10 **Example 1**

**2-[1-(5-butyl-1,3,4-oxadiazol-2-yl)-1-methylethyl]-5-(3,5-dimethylphenyl)-4-{2-[4-(2-oxo-2-pyrrolidin-1-ylethyl)piperazin-1-yl]ethyl}-6H-thieno[2,3-b]pyrrole**



3

Example 1

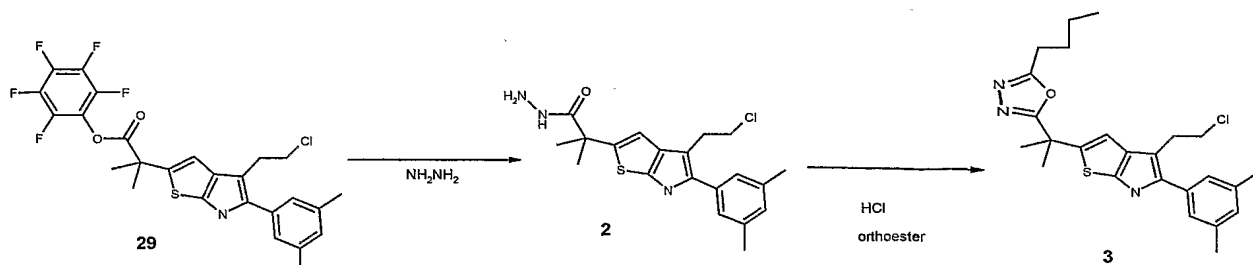
A mixture of 2-[1-(5-butyl-1,3,4-oxadiazol-2-yl)-1-methylethyl]-4-(2-chloroethyl)-5-(3,5-dimethylphenyl)-6H-thieno[2,3-b]pyrrole (224mg, 0.49mmol), tetrabutylammonium iodide (0.27g, 0.73mmol), diisopropylethylamine (0.20ml, 1.47mmol), 1-(2-oxo-2-pyrrolidin-1-ylethyl)piperazine (0.19g, 0.96mmol) in 1,4-dioxane (5ml) was heated to 140°C in a microwave for 2 hours. The mixture was partitioned between methylene chloride (50ml) and water (50ml) and the organic layer was evaporated. The residue was purified by flash chromatography eluting with Methanol/Methylene chloride (5% Methanol) to give the title product as a foam (65 mg).

Yield : 21%

<sup>1</sup>H NMR spectrum (DMSO) : 0.87 (t, 3H); 1.33 (m, 2H); 1.64 (m, 2H); 1.75 (m, 2H); 1.82 (m, 8H); 2.31 (s, 6H); 2.51 (m, 10H); 2.77-2.90 (m, 4H); 3.08 (s, 2H); 3.28 (m, 2H); 3.44 (m, 2H); 6.92 (s, 2H); 7.08 (s, 2H); 11.28 (s, 1H).

MS-ESI : 617 [M+H]<sup>+</sup>

The starting materials were prepared as follows:



5 2-[4-(2-chloroethyl)-5-(3,5-dimethylphenyl)-6H-thieno[2,3-b]pyrrol-2-yl]-2-methylpropanohydrazide (2)

A mixture of 1 (3.60g, 6.64mmol), hydrazine monohydrate (0.36ml, 7.42mmol), diisopropylethylamine (1.39ml, 7.98mmol) in 1,4-dioxane (50ml) was stirred at room temperature for 1 hour to give 2. This solution was used directly in subsequent reactions.

10

2-[1-(5-butyl-1,3,4-oxadiazol-2-yl)-1-methylethyl]-4-(2-chloroethyl)-5-(3,5-dimethylphenyl)-6H-thieno[2,3-b]pyrrole (3)

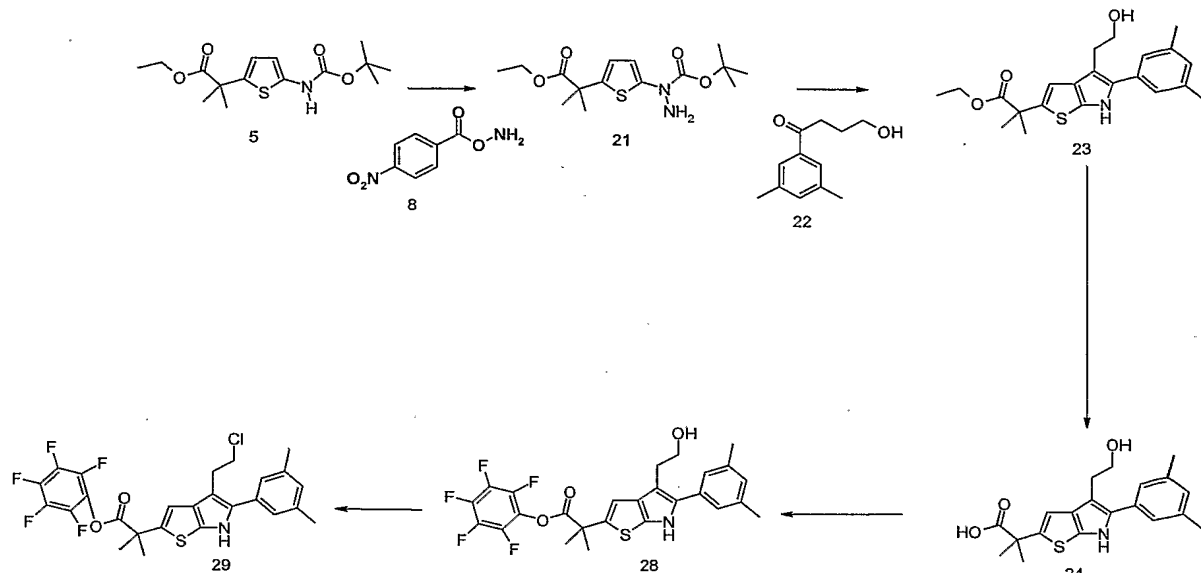
To one portion of 2 (approx 11ml in 1,4-dioxane, 1.11mmol) was added HCl (1.7ml, 4M in 1,4-dioxane), and trimethylorthovalerate (2g, 12.3mmol). After stirring for 30 minutes the  
 15 solution was washed with aqueous sodium hydroxide (20ml, 2M), evaporated and the residue purified using flash column chromatography eluting with methanol (1.5%) and methylene chloride (98.5%) gave 2-[1-(5-butyl-1,3,4-oxadiazol-2-yl)-1-methylethyl]-4-(2-chloroethyl)-5-(3,5-dimethylphenyl)-6H-thieno[2,3-b]pyrrole as an oil (224mg).

Yield : 44%

20 MS-ESI : 456 [M+H]<sup>+</sup>

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The intermediate **29** was prepared as follows:



To a suspension of sodium hydride (44.6 g ; 1.12 mol) in DMF (700 ml) at 10°C, was added a solution of **5** (290 g ; 930 mmol) in DMF (1 l) over a period of 5 minutes. The resulting orange suspension was allowed to warm to room temperature and stirred for 2 hours. The resulting solution was cooled to -5°C in an acetone/ice bath and a solution of **8** (201 g ; 1.02 mol) in DMF (1.4 l) was added over a period of 1 hour. During this period additional DMF (1 l) was added to mobilize the thick precipitate which formed. The resulting suspension was allowed to warm to room temperature and stirred over night after which HPLC showed no remaining starting material. The suspension was poured into water (6 l) and extracted with diethyl ether (3x2 l). The organic extracts were combined and concentrated to approximately 3 l and washed with water (4x1.5 l), a saturated solution of brine (1 l), dried over magnesium sulfate and evaporated to dryness to afford the free base as an off-white solid in quantitative yield. To a stirred solution of the free base (150 g ; 457 mmol) in diethyl ether (1.2 l) and heptane (600 ml) at 0°C, was added a 4.0M solution of HCl in 1,4-dioxane (145 ml ; 570 mmol) over a period of 1 hour. The resulting thick, white precipitate was collected by filtration, washed with a mixture of diethyl ether-heptane (1:1, 500 ml) and dried to a constant weight to afford the **21.HCl** (160.3 g) as a white solid.

Yield: 96%

MS-ESI: 328 [M+H]<sup>+</sup>

To a stirred solution of **21** (141 g; 380 mmol) in 2-butanol (1.3 l) was added **22** (104 g; 540 mmol) and zinc chloride (106 g; 770 mmol). The resulting suspension was heated at 100°C

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for 8 hours after which HPLC showed no remaining starting material. The resulting dark brown solution was evaporated to dryness on a rotary evaporator. The resulting dark brown residue was dissolved in DCM (100 ml), filtered and the filtrate was purified by flash chromatography eluting with DCM, ethyl acetate (9:1) to afford **23** (98 g) as a brown solid.

5 Yield: 67%

MS-ESI: 386 [M+H]<sup>+</sup>

To a stirred solution of **23** (98 g; 254 mmol) in ethanol (1.8 l) was added 1N NaOH (1.27 l, 1270 mmol). The resulting solution was heated at 60°C for 4 hours after which HPLC showed  
10 no remaining starting material. The reaction mixture was cooled to room temperature and the ethanol was removed on a rotary evaporator. The resulting brown solution was cooled to 5°C and concentrated HCl was added dropwise with rapid agitation decreasing the pH to 1. The resulting precipitate was collected by filtration, washed to a neutral pH with water (3x1 l) and dried to a constant weight in a vacuum oven at 50°C to afford **24** as a beige solid (68.3 g).

15 Yield: 75%

MS-ESI: 358 [M+H]<sup>+</sup>

Pentafluorophenyl 2-[5-(3,5-dimethylphenyl)-4-(2-hydroxyethyl)-6*H*-thieno[2,3-*b*]pyrrol-2-yl]-2-methylpropanoate (**28**)

20 To a solution of 2-[5-(3,5-dimethylphenyl)-4-(2-hydroxyethyl)-6*H*-thieno[2,3-*b*]pyrrol-2-yl]-2-methylpropanoic acid (**24**) (9.57g, 26.8mmol) in dichloromethane (250mL) was added *N,N*-diisopropylethylamine (13.1mL, 75.0mmol), followed by pentafluorophenol (6.52g, 34.8mmol) then O-(7-azabenzotriazol-1-yl)-*N,N,N',N'*-tetramethyluronium hexafluorophosphate (10.69g, 28.1mmol). The mixture was stirred at ambient temperature for  
25 20 hours, then washed with saturated aqueous NaHCO<sub>3</sub> solution (250mL). Organics were dried (MgSO<sub>4</sub>) then concentrated to yield a brown oil. Purification by flash chromatography (eluent: ethyl acetate / isohexane 20:80) afforded the **28** as a dark yellow solid. Yield 10.40g, 19.9mmol, 74%.

NMR (300MHz, CDCl<sub>3</sub>) 1.50 (t, 1H), 1.85 (s, 6H), 2.36 (s, 6H), 3.05 (t, 2H), 3.93 (q, 2H),  
30 6.96 (s, 1H), 7.03 (s, 1H), 7.09, (s, 2H), 8.21 (s, 1H). MS: ES<sup>+</sup> 524, ES<sup>-</sup> 522.



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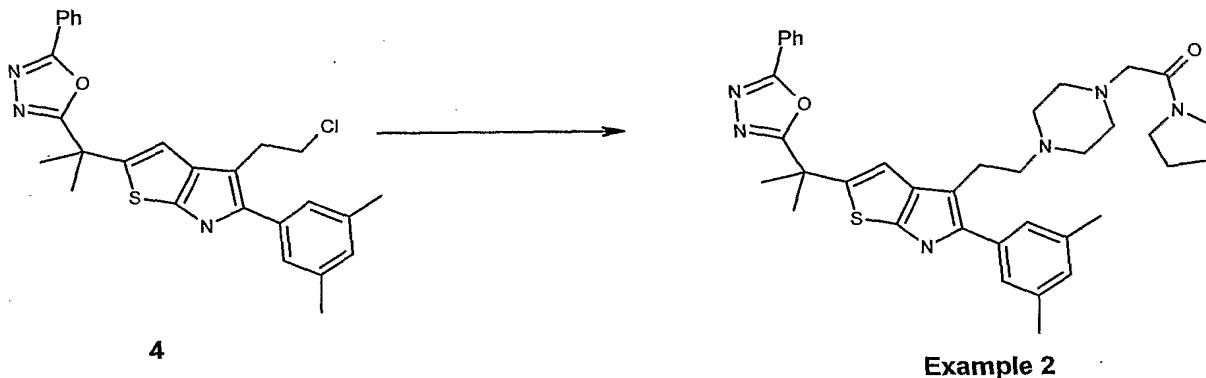
Pentafluorophenyl 2-[4-(2-chloroethyl)-5-(3,5-dimethylphenyl)-6*H*-thieno[2,3-*b*]pyrrol-2-yl]-2-methylpropanoate (29)

To a stirred solution of pentafluorophenyl 2-[5-(3,5-dimethylphenyl)-4-(2-hydroxyethyl)-6*H*-thieno[2,3-*b*]pyrrol-2-yl]-2-methylpropanoate (**28**) (2.96g, 5.65mmol) in acetonitrile (30mL) was added carbon tetrachloride (6mL). The mixture was cooled to 0°C, then a solution of triphenylphosphine (4.45g, 17.0mmol) in acetonitrile (15mL) was added dropwise. The mixture was stirred at 0°C for a further 15 minutes, then allowed to warm to room temperature and stirred for 2 hours. The resultant dark red solution was concentrated *in vacuo*, then chromatographed (eluent: ethyl acetate / isohexane 10:90), to afford the **29** as an orange solid. Yield 2.79g, 5.16mmol, 91%.

NMR (300MHz, CDCl<sub>3</sub>) 1.85 (s, 6H), 2.36 (s, 6H), 3.23 (t, 2H), 3.75 (t, 2H), 6.97 (s, 1H), 7.00 (s, 1H), 7.03 (s, 2H), 8.13 (s, 1H). MS: ES<sup>+</sup> 540.

**Example 2**

**5-(3,5-dimethylphenyl)-2-[1-methyl-1-(5-phenyl-1,3,4-oxadiazol-2-yl)ethyl]-4-{2-[4-(2-oxo-2-pyrrolidin-1-ylethyl)piperazin-1-yl]ethyl}-6*H*-thieno[2,3-*b*]pyrrole**



A mixture of 4-(2-chloroethyl)-5-(3,5-dimethylphenyl)-2-[1-methyl-1-(5-phenyl-1,3,4-oxadiazol-2-yl)ethyl]-6*H*-thieno[2,3-*b*]pyrrole (**4**) (135mg, 0.28mmol), tetrabutylammonium iodide (0.16g, 0.43mmol), diisopropylethylamine (0.12ml, 0.69mmol), 1-(2-oxo-2-pyrrolidin-1-ylethyl)piperazine (0.11g, 0.56mmol) in 1,4-dioxane (5ml) was heated to 140°C in a microwave for 2 hours. The mixture was partitioned between methylene chloride (50ml) and water (50ml) and the organic layer was evaporated. The residue was purified by flash chromatography eluting with Methanol/Methylene chloride (5% Methanol) to give a foam. This was solidified by stirring in diethyl ether (10ml) to give the title product (0.048g).

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Yield : 27%

$^1\text{H}$  NMR spectrum (DMSO, 373K) : 1.81 (m, 4H); 1.93 (s, 6H); 2.31 (s, 6H); 2.50 (m, 8H); 2.87 (m, 2H); 2.95 (m, 2H); 3.08 (s, 2H); 3.28-3.52 (m, 4H); 6.92 (s, 1H); 6.98 (s, 1H); 7.07 (s, 2H); 7.58 (m, 3H); 7.96 (m, 2H); 11.28 (s, 1H).

5 MS-ESI : 637  $[\text{M}+\text{H}]^+$

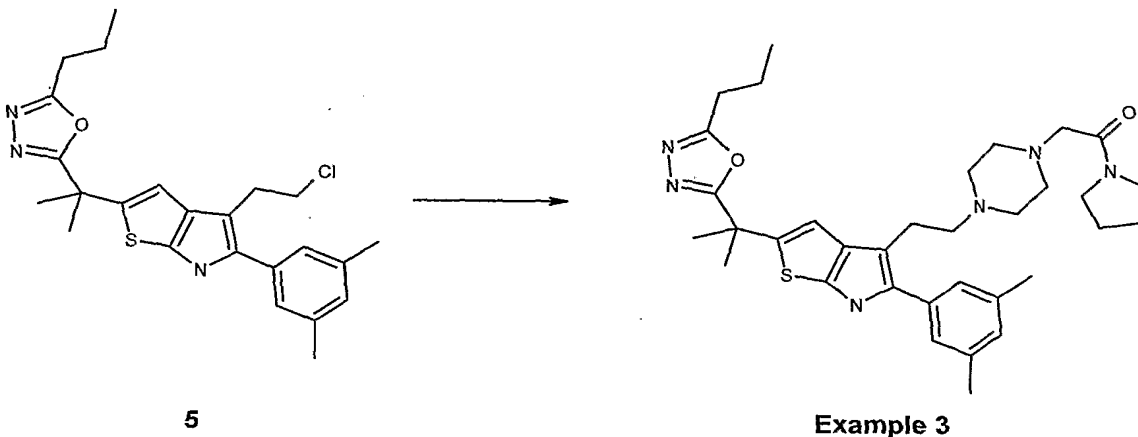
The starting material (4) was prepared as follows:

To one portion of **2** (see Example 1) (approx 11ml in 1,4-dioxane, 1.11mmol) was added was added HCl (1.7ml, 4M in 1,4-dioxane), and triethylorthobenzoate (2g, 8.92mmol). After  
 10 stirring for 30 minutes the solution was washed with aqueous sodium hydroxide (20ml, 2M), evaporated and the residue purified using flash column chromatography eluting with increasingly polar mixtures of methylene chloride / methanol (99/1 to 98/2) to give 4-(2-chloroethyl)-5-(3,5-dimethylphenyl)-2-[1-methyl-1-(5-phenyl-1,3,4-oxadiazol-2-yl)ethyl]-6H-thieno[2,3-*b*]pyrrole (**4**) as an oil (135mg, 26%). MS-ESI : 476  $[\text{M}+\text{H}]^+$ .

15

### Example 3

5-(3,5-dimethylphenyl)-2-[1-methyl-1-(5-propyl-1,3,4-oxadiazol-2-yl)ethyl]-4-{2-[4-(2-oxo-2-pyrrolidin-1-ylethyl)piperazin-1-yl]ethyl}-6H-thieno[2,3-*b*]pyrrole



20 A mixture of 4-(2-chloroethyl)-5-(3,5-dimethylphenyl)-2-[1-methyl-1-(5-propyl-1,3,4-oxadiazol-2-yl)ethyl]-6H-thieno[2,3-*b*]pyrrole (**5**) (298mg, 0.67mmol), tetrabutylammonium iodide (0.37g, 1.00mmol), diisopropylethylamine (0.27ml, 1.55mmol), 1-(2-oxo-2-pyrrolidin-1-ylethyl)piperazine (0.26g, 1.32mmol) in 1,4-dioxane (5ml) was heated to 140°C in a microwave for 2 hours. The mixture was partitioned between methylene chloride (50ml) and  
 25 water (50ml) and the organic layer was evaporated. The residue was purified by flash column

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chromatography eluting with methylene chloride / methanol (95/5) to give the title product as a foam (0.073g).

Yield : 18%

$^1\text{H}$  NMR spectrum (DMSO, 373K) : 0.89 (t, 3H); 1.31 (m, 2H); 1.42 (m, 2H); 1.71-1.87 (m, 4H); 1.83 (s, 6H); 2.30 (s, 6H); 2.50 (m, 8H); 2.59 (m, 2H); 2.78 (m, 2H); 2.87 (m, 2H); 3.08 (s, 2H); 3.26-3.51 (m, 2H); 6.90 (s, 1H); 6.94 (s, 1H); 7.07 (s, 2H); 10.97 (s, 1H).

MS-ESI : 603  $[\text{M}+\text{H}]^+$

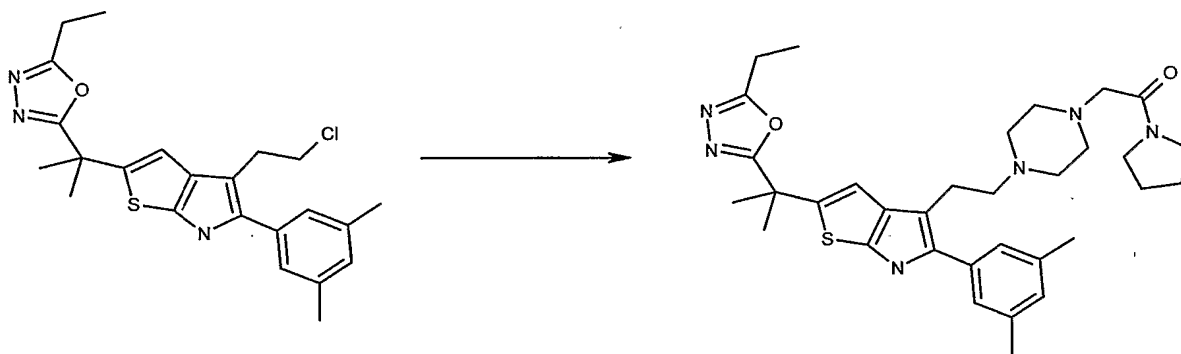
The starting material (5) was prepared as follows:

- 10 To one portion of **2** (see Example 1) (approx 11ml in 1,4-dioxane, 1.11mmol) was added was added HCl (1.7ml, 4M in 1,4-dioxane), and trimethylorthobutyrate (2g, 13.5mmol). After stirring for 30 minutes the solution was washed with aqueous sodium hydroxide (20ml, 2M), evaporated and the residue purified using flash column chromatography eluting with methylene chloride / methanol (98.5/1.5) to give 4-(2-chloroethyl)-5-(3,5-dimethylphenyl)-2-[1-methyl-1-(5-propyl-1,3,4-oxadiazol-2-yl)ethyl]-6H-thieno[2,3-b]pyrrole (**5**) as an oil
- 15 (298mg, 61%).

MS-ESI : 442  $[\text{M}+\text{H}]^+$ .

#### Example 4

- 20 **5-(3,5-dimethylphenyl)-2-[1-(5-ethyl-1,3,4-oxadiazol-2-yl)-1-methylethyl]-4-{2-[4-(2-oxo-2-pyrrolidin-1-ylethyl)piperazin-1-yl]ethyl}-6H-thieno[2,3-b]pyrrole**



6

Example 4

- A mixture of 4-(2-chloroethyl)-5-(3,5-dimethylphenyl)-2-[1-(5-ethyl-1,3,4-oxadiazol-2-yl)-1-methylethyl]-6H-thieno[2,3-b]pyrrole (**6**) (257mg, 0.60mmol), tetrabutylammonium iodide (0.33g, 0.89mmol), diisopropylethylamine (0.24ml, 1.38mmol), 1-(2-oxo-2-pyrrolidin-1-ylethyl)piperazine (0.23g, 1.17mmol) in 1,4-dioxane (5ml) was heated to 140°C in a
- 25

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microwave for 2 hours. The mixture was partitioned between methylene chloride (50ml) and water (50ml) and the organic layer was evaporated. The residue was purified by flash column chromatography eluting with increasingly polar mixtures of methylene chloride / methanol (99/1 to 98/2) to give a foam. This was solidified by stirring in diethyl ether (10ml) to give

5 the title product (0.132g).

Yield : 37%

<sup>1</sup>H NMR spectrum (DMSO, 373K) : 1.27 (t, 3H); 1.73-1.90 (m, 4H); 1.83 (s, 6H); 2.30 (s, 6H); 2.49 (m, 8H); 2.59 (m, 1H); 2.64 (m, 1H); 2.80 (q, 2H); 2.84-2.90 (m, 2H); 2.87 (m, 2H); 3.11 (s, 2H); 3.26-3.51 (m, 2H); 6.90 (s, 1H); 6.94 (s, 1H); 7.07 (s, 2H); 10.97 (s, 1H).

10 MS-ESI : 589 [M+H]<sup>+</sup>

The starting material (6) was prepared as follows:

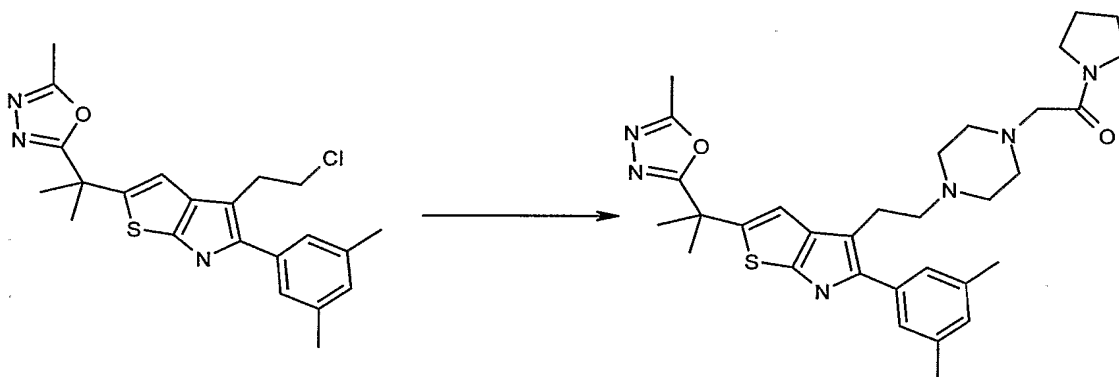
To one portion of 2 (see Example 1) (approx 11ml in 1,4-dioxane, 1.11mmol) was added was added HCl (1.7ml, 4M in 1,4-dioxane), and triethylorthopropionate (2g, 11.3mmol).

15 After stirring for 30 minutes the solution was washed with aqueous sodium hydroxide (20ml, 2M), evaporated and the residue purified using flash column chromatography eluting with methylene chloride / methanol (98.5/1.5) to give 4-(2-chloroethyl)-5-(3,5-dimethylphenyl)-2-[1-(5-ethyl-1,3,4-oxadiazol-2-yl)-1-methylethyl]-6H-thieno[2,3-*b*]pyrrole (6) as an oil (257mg, 54%).

20 MS-ESI : 428 [M+H]<sup>+</sup>.

### Example 5

5-(3,5-dimethylphenyl)-2-[1-methyl-1-(5-methyl-1,3,4-oxadiazol-2-yl)ethyl]-4-{2-[4-(2-oxo-2-pyrrolidin-1-ylethyl)piperazin-1-yl]ethyl}-6H-thieno[2,3-*b*]pyrrole



Example 5

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A mixture of 4-(2-chloroethyl)-5-(3,5-dimethylphenyl)-2-[1-methyl-1-(5-methyl-1,3,4-oxadiazol-2-yl)ethyl]-6*H*-thieno[2,3-*b*]pyrrole (7) (219mg, 0.53mmol), tetrabutylammonium iodide (0.29g, 0.79mmol), diisopropylethylamine (0.21ml, 1.21mmol), 1-(2-oxo-2-pyrrolidin-1-ylethyl)piperazine (0.20g, 1.01mmol) in 1,4-dioxane (5ml) was heated to 140°C in a  
5 microwave for 2 hours. The mixture was partitioned between methylene chloride (50ml) and water (50ml) and the organic layer was evaporated. The residue was purified by flash column chromatography eluting with methylene chloride / methanol (95/5) to give a foam. This was solidified by stirring in diethyl ether (10ml) to give the title product (0.114g).

Yield : 37%

10 <sup>1</sup>H NMR spectrum (DMSO) : 1.75 (m, 2H); 1.83-1.90 (m, 2H); 1.83 (s, 6H); 2.31 (s, 6H); 2.45 (s, 3H); 2.50-2.65 (m, 8H); 2.86 (m, 2H); 2.87 (m, 2H); 3.12 (br s, 2H); 3.26-3.32 (m, 2H); 3.46 (m, 2H); 6.92 (s, 1H); 6.97 (s, 1H); 7.08 (s, 2H); 11.29 (s, 1H).

MS-ESI : 575 [M+H]<sup>+</sup>

15 The starting material (7) was prepared as follows:

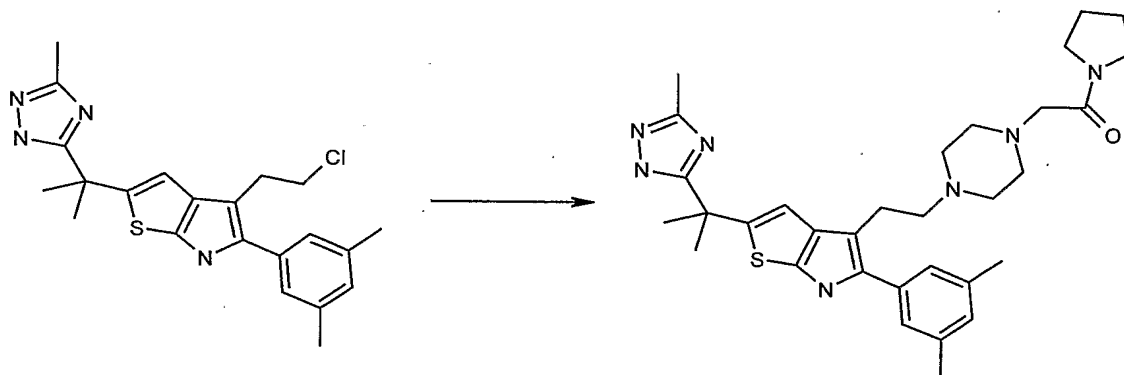
To one portion of 2 (see Example 1) (approx 11ml in 1,4-dioxane, 1.11mmol) was added was added HCl (1.7ml, 4M in 1,4-dioxane), and trimethylorthoacetate (2g, 12.3mmol). After stirring for 30 minutes the solution was washed with aqueous sodium hydroxide (20ml, 2M),  
20 evaporated and the residue purified using flash column chromatography eluting with increasingly polar mixtures of methylene chloride / methanol (98.5/1.5 to 97/3) to give 4-(2-chloroethyl)-5-(3,5-dimethylphenyl)-2-[1-methyl-1-(5-methyl-1,3,4-oxadiazol-2-yl)ethyl]-6*H*-thieno[2,3-*b*]pyrrole (7) as an oil (219mg, 48%).

MS-ESI : 414 [M+H]<sup>+</sup>.

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**Example 6**

**5-(3,5-dimethylphenyl)-2-[1-methyl-1-(5-methyl-4*H*-1,2,4-triazol-3-yl)ethyl]-4-{2-[4-(2-oxo-2-pyrrolidin-1-ylethyl)piperazin-1-yl]ethyl}-6*H*-thieno[2,3-*b*]pyrrole**

**8****Example 6**

- 5 A mixture of 4-(2-chloroethyl)-5-(3,5-dimethylphenyl)-2-[1-methyl-1-(5-methyl-4*H*-1,2,4-triazol-3-yl)ethyl]-6*H*-thieno[2,3-*b*]pyrrole (190mg, 0.46mmol), tetrabutylammonium iodide (8) (0.25g, 0.68mmol), diisopropylethylamine (0.18ml, 1.03mmol), 1-(2-oxo-2-pyrrolidin-1-ylethyl)piperazine (0.18g, 0.91mmol) in 1,4-dioxane (5ml) was heated to 145°C in a microwave for 2.5 hours. The mixture was partitioned between methylene chloride (50ml)
- 10 and water (50ml) and the organic layer was evaporated. The residue was purified by flash column chromatography eluting with increasingly polar mixtures of methylene chloride / 7*N* ammonia solution in methanol (96/4 to 90/10) to give a foam. This was solidified by stirring in diethyl ether (10ml) to give the title product (0.070g).

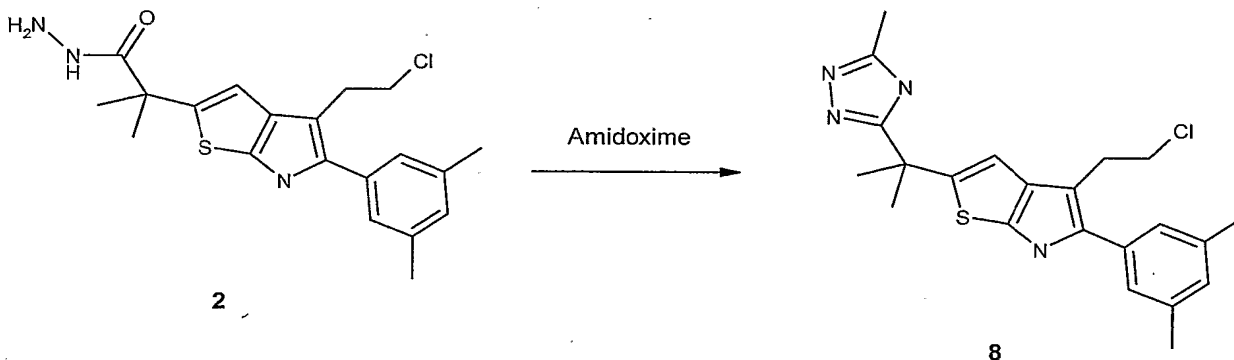
Yield : 27%

- 15 <sup>1</sup>H NMR spectrum (DMSO) : 1.82-1.98 (m, 4H); 1.82 (s, 6H); 2.30 (br s, 3H); 2.34 (s, 6H); 2.45-2.57 (m, 8H); 2.58 (m, 2H); 2.83 (m, 2H); 3.08 (s, 2H); 3.22-3.58 (m, 4H); 6.77 (s, 1H); 6.90 (s, 1H); 7.08 (s, 2H); 10.80 (br s, 1H) ; 12.90 (br s, 1H).

MS-ESI : 574 [M+H]<sup>+</sup>

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The starting material (**8**) was prepared as follows:

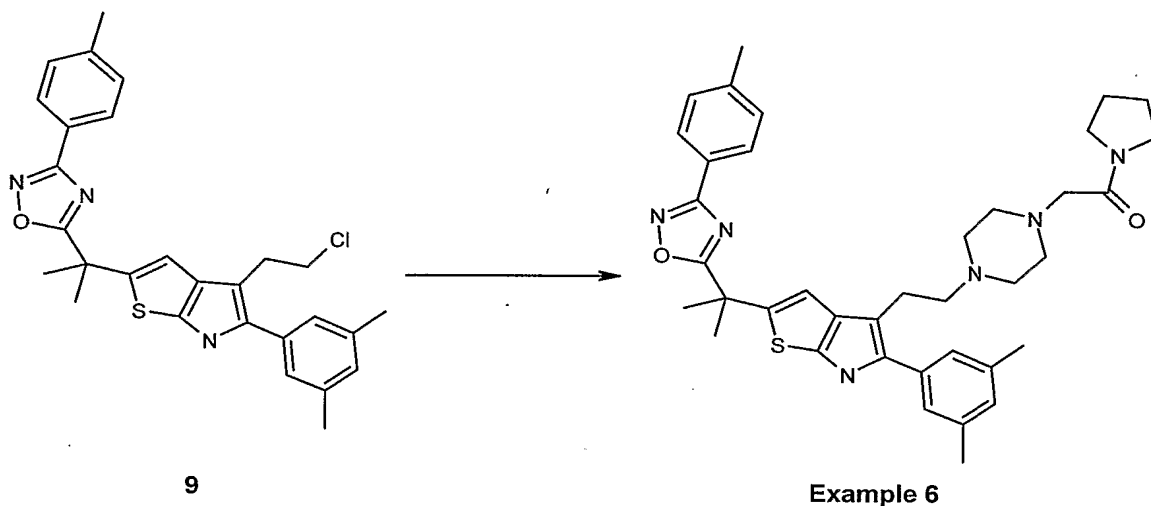


To one portion of **2** (see Example 1) (approx 5ml in 1,4-dioxane, 0.57mmol) was added acetamidine hydrochloride (0.11g, 1.16mmol), diisopropylamine (0.20ml, 1.15mmol) and 4Å molecular sieves (100mg). The mixture was heated at 100°C in a microwave for 2 hours. The mixture was partitioned between methylene chloride (50ml) and water (50ml) and the organic layer was evaporated. The residue was purified by flash chromatography eluting with Methanol/Methylene chloride (5% Methanol) to give 4-(2-chloroethyl)-5-(3,5-dimethylphenyl)-2-[1-methyl-1-(5-methyl-4H-1,2,4-triazol-3-yl)ethyl]-6H-thieno[2,3-b]pyrrole (**8**) as a yellow oil that slowly solidified (0.190g, 80%).

MS-ESI : 413 [M+H]<sup>+</sup>.

### Example 7

5-(3,5-dimethylphenyl)-2-{1-methyl-1-[3-(4-methylphenyl)-1,2,4-oxadiazol-5-yl]ethyl}-4-{2-[4-(2-oxo-2-pyrrolidin-1-ylethyl)piperazin-1-yl]ethyl}-6H-thieno[2,3-b]pyrrole



A mixture of 4-(2-chloroethyl)-5-(3,5-dimethylphenyl)-2-[1-methyl-1-[3-(4-methylphenyl)-1,2,4-oxadiazol-5-yl]ethyl]-6H-thieno[2,3-b]pyrrole (**9**) (190mg, 0.46mmol),

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tetrabutylammonium iodide (0.15g, 0.41mmol), diisopropylethylamine (0.11ml, 0.63mmol), 1-(2-oxo-2-pyrrolidin-1-ylethyl)piperazine (0.10g, 0.51mmol) in 1,4-dioxane (5ml) was heated to 140°C in a microwave for 2 hours. The mixture was partitioned between methylene chloride (50ml) and water (50ml) and the organic layer was evaporated. The residue was

5 purified by flash column chromatography eluting with increasingly polar mixtures of methylene chloride / methanol (97/3 to 93/7) to give a foam (0.030g).

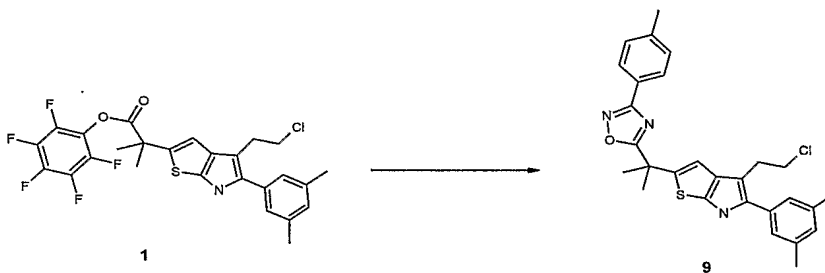
Yield : 17%

<sup>1</sup>H NMR spectrum (DMSO) : 1.74 (m, 2H); 1.84 (m, 2H); 1.94 (s, 6H); 2.31 (s, 6H); 2.39 (s, 3H); 2.45-2.56 (m, 10H); 2.85 (m, 2H); 3.06 (s, 2H); 3.22-3.32 (m, 2H); 3.45 (m, 2H); 6.92

10 (s, 1H); 7.07 (s, 1H); 7.08 (s, 2H); 7.37 (d, 2H); 7.90 (d, 2H); 11.30 (br s, 1H).

MS-ESI : 651 [M+H]<sup>+</sup>

The starting material (**9**) was prepared as follows:



15 A mixture of **1** (see Example 1) (0.200g, 0.369mmol) and 4-methylbenzamidoxime (0.110g, 0.733mmol) in methylene chloride (5ml) were stirred for 3 hours at room temperature. The solution was then heated to 100°C in a microwave for 90 minutes. After cooling, methylene chloride (50ml) was added and the solution was washed with aqueous sodium hydroxide (50ml, 2M). The residue was purified by flash chromatography eluting with methylene

20 chloride to give 4-(2-chloroethyl)-5-(3,5-dimethylphenyl)-2-{1-methyl-1-[3-(4-methylphenyl)-1,2,4-oxadiazol-5-yl]ethyl}-6H-thieno[2,3-*b*]pyrrole (**9**) as a yellow oil (0.130g, 72%). MS-ESI : 490 [M+H]<sup>+</sup>.

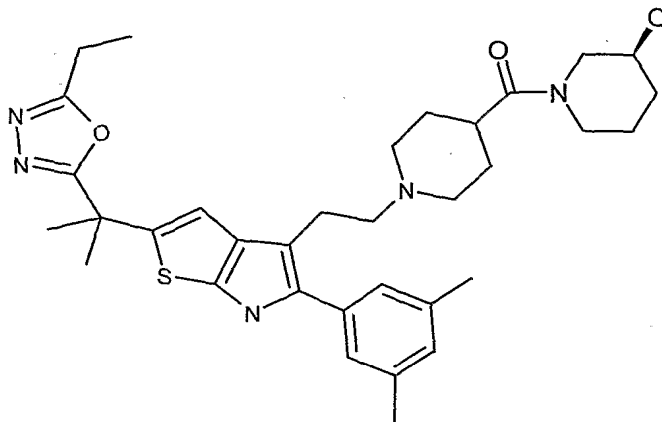


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**Example 8**

**(3*S*)-1-[[1-(2-{5-(3,5-dimethylphenyl)-2-[1-(5-ethyl-1,3,4-oxadiazol-2-yl)-1-methylethyl]-6*H*-thieno[2,3-*b*]pyrrol-4-yl}ethyl)piperidin-4-yl]carbonyl]piperidin-3-ol**

5



A mixture of 4-(2-chloroethyl)-5-(3,5-dimethylphenyl)-2-[1-(5-ethyl-1,3,4-oxadiazol-2-yl)-1-methylethyl]-6*H*-thieno[2,3-*b*]pyrrole (150mg, 0.35mmol), tetrabutylammonium iodide (0.19g, 0.51mmol), diisopropylethylamine (0.14ml, 0.80mmol), (3*S*)-1-(piperidin-4-ylcarbonyl)piperidin-3-ol (0.15g, 0.70mmol) in 1,4-dioxane (5ml) was heated to 140°C in a microwave for 4 hours. The mixture was partitioned between methylene chloride (50ml) and water (50ml) and the organic layer was evaporated. The residue was purified by flash column chromatography eluting with increasingly polar mixtures of methylene chloride / methanol (99/1 to 95/5) to give a foam. This was solidified by stirring in diethyl ether (10ml) to give the title product (0.017g).

Yield : 8%

<sup>1</sup>H NMR spectrum (DMSO, 373K) : 1.27 (t, 3H); 1.38 (m, 1H); 1.63 (m, 5H); 1.84 (m, 1H); 1.85(s, 6H); 2.20 (m, 1H); 2.30 (s, 6H); 2.58 (m, 1H); 2.82 (q, 2H); 2.88-3.10 (m, 9H); 3.11 (s, 2H); 3.48 (m, 1H); 3.65 (m, 1H); 4.46 (m, 1H); 6.90 (m, 2H); 7.12 (s, 2H); 10.97 (s, 1H).

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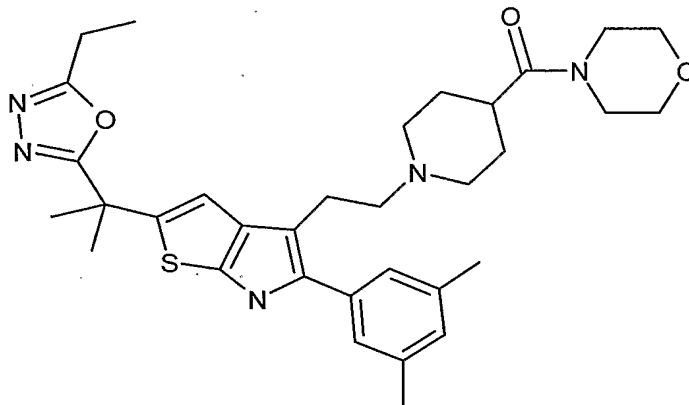
MS-ESI : 604 [M+H]<sup>+</sup>

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**Example 9**

**5-(3,5-dimethylphenyl)-2-[1-(5-ethyl-1,3,4-oxadiazol-2-yl)-1-methylethyl]-4-{2-[4-(morpholin-4-ylcarbonyl)piperidin-1-yl]ethyl}-6*H*-thieno[2,3-*b*]pyrrole**

5



A mixture of 4-(2-chloroethyl)-5-(3,5-dimethylphenyl)-2-[1-(5-ethyl-1,3,4-oxadiazol-2-yl)-1-methylethyl]-6*H*-thieno[2,3-*b*]pyrrole (150mg, 0.35mmol), tetrabutylammonium iodide

10 (0.19g, 0.51mmol), diisopropylethylamine (0.14ml, 0.80mmol), 4-(piperidin-4-ylcarbonyl)morpholine (0.14g, 0.70mmol) in 1,4-dioxane (5ml) was heated to 140°C in a microwave for 4 hours. The mixture was partitioned between methylene chloride (50ml) and water (50ml) and the organic layer was evaporated. The residue was purified by flash column chromatography eluting with increasingly polar mixtures of methylene chloride / methanol

15 (99/1 to 95/5) to give a foam. This was solidified by stirring in diethyl ether (10ml) to give the title product (0.067g).

Yield : 32%

<sup>1</sup>H NMR spectrum (DMSO, 373K) : 1.27 (t, 3H); 1.62 (m, 4H); 1.85(s, 6H); 2.20 (m, 1H); 2.30 (s, 6H); 2.58 (m, 1H); 2.66 (m, 1H); 2.82 (q, 2H); 2.88-3.10 (m, 6H); 3.46(m, 4H); 3.58

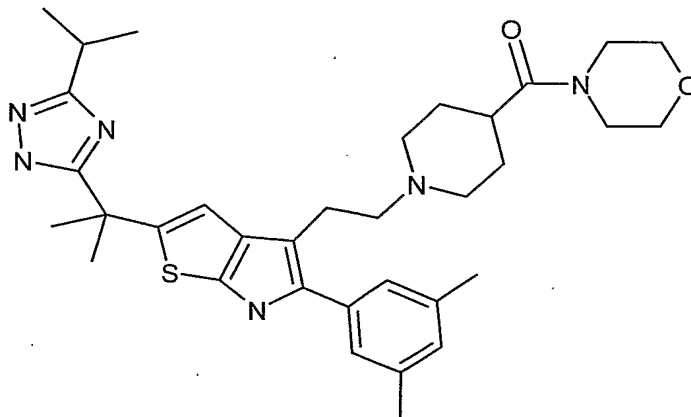
20 (m, 4H); 6.90 (m, 2H); 7.12 (s, 2H); 10.97 (s, 1H).

MS-ESI : 590 [M+H]<sup>+</sup>

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**Example 10**

**5-(3,5-dimethylphenyl)-2-[1-(3-isopropyl-1*H*-1,2,4-triazol-5-yl)-1-methylethyl]-4-{2-[4-(morpholin-4-ylcarbonyl)piperidin-1-yl]ethyl}-6*H*-thieno[2,3-*b*]pyrrole**



5

A mixture of 4-(2-chloroethyl)-5-(3,5-dimethylphenyl)-2-[1-(3-isopropyl-1*H*-1,2,4-triazol-5-yl)-6*H*-thieno[2,3-*b*]pyrrole (200mg, 0.46mmol), tetrabutylammonium iodide (0.25g, 0.68mmol), diisopropylethylamine (0.18ml, 1.03mmol), 4-(piperidin-4-ylcarbonyl)morpholine (0.18g, 0.90mmol) in 1,4-dioxane (5ml) was heated to 140°C in a microwave for 2.5 hours. The mixture was partitioned between methylene chloride (50ml) and water (50ml) and the organic layer was evaporated. The residue was purified by flash column chromatography eluting with increasingly polar mixtures of methylene chloride / 7N ammonia solution in methanol (96/4 to 90/10) to give a foam. This was solidified by stirring in diethyl ether (10ml) to give the title product (0.017g).

15 Yield : 6%

<sup>1</sup>H NMR spectrum (DMSO) : 1.29 (d, 6H); 1.58-1.72 (m, 3H); 1.79 (m, 1H); 1.80 (s, 6H); 2.13 (m, 2H); 2.33 (s, 6H); 2.61 (m, 2H); 2.87 (m, 2H); 2.95-3.06 (m, 4H); 3.48 (m, 4H); 3.59(m, 4H); 6.77 (s, 1H); 6.92 (s, 1H); 7.12 (s, 2H); 10.80 (s, 1H) ; 12.92 (br s, 1H).

MS-ESI : 603 [M+H]<sup>+</sup>

20

**THERAPEUTIC USES**

Compounds of Formula (I) are provided as medicaments for antagonising gonadotropin releasing hormone (GnRH) activity in a patient, eg, in men and/or women. To this end, a compound of Formula (I) can be provided as part of a pharmaceutical formulation which also includes a pharmaceutically acceptable diluent or carrier (eg, water). The

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formulation may be in the form of tablets, capsules, granules, powders, syrups, emulsions (eg, lipid emulsions), suppositories, ointments, creams, drops, suspensions (eg, aqueous or oily suspensions) or solutions (eg, aqueous or oily solutions). If desired, the formulation may include one or more additional substances independently selected from stabilising agents, wetting agents, emulsifying agents, buffers, lactose, sialic acid, magnesium stearate, terra alba, sucrose, corn starch, talc, gelatin, agar, pectin, peanut oil, olive oil, cacao butter and ethylene glycol.

The compound is preferably orally administered to a patient, but other routes of administration are possible, such as parenteral or rectal administration. For intravenous, subcutaneous or intramuscular administration, the patient may receive a daily dose of  $0.1\text{mgkg}^{-1}$  to  $30\text{mgkg}^{-1}$  (preferably,  $5\text{mgkg}^{-1}$  to  $20\text{mgkg}^{-1}$ ) of the compound, the compound being administered 1 to 4 times per day. The intravenous, subcutaneous and intramuscular dose may be given by means of a bolus injection. Alternatively, the intravenous dose may be given by continuous infusion over a period of time. Alternatively, the patient may receive a daily oral dose which is approximately equivalent to the daily parenteral dose, the composition being administered 1 to 4 times per day. A suitable pharmaceutical formulation is one suitable for oral administration in unit dosage form, for example as a tablet or capsule, which contains between 10mg and 1g (preferably, 100 mg and 1g) of the compound of the invention.

Buffers, pharmaceutically acceptable co-solvents (eg, polyethylene glycol, propylene glycol, glycerol or EtOH) or complexing agents such as hydroxy-propyl  $\beta$  cyclodextrin may be used to aid formulation.

One aspect of the invention relates to the use of compounds according to the invention for reducing the secretion of LH and/or FSH by the pituitary gland of a patient. In this respect, the reduction may be by way of a reduction in biosynthesis of the LH and FSH and/or a reduction in the release of LH and FSH by the pituitary gland. Thus, compounds according to the invention can be used for therapeutically treating and/or preventing a sex hormone related condition in the patient. By "preventing" we mean reducing the patient's risk of contracting the condition. By "treating" we mean eradicating the condition or reducing its severity in the patient. Examples of sex hormone related conditions are: a sex hormone dependent cancer, benign prostatic hypertrophy, myoma of the uterus, endometriosis, polycystic ovarian disease, uterine fibroids, prostatauxie, myoma uteri, hirsutism and precocious puberty. Examples of sex hormone dependent cancers are: prostatic cancer,

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uterine cancer, breast cancer and pituitary gonadotrophe adenoma.

The compounds of the invention may be used in combination with other drugs and therapies used to treat / prevent sex-hormone related conditions.

If formulated as a fixed dose such combination products employ the compounds of  
5 this invention within the dosage range described herein and the other pharmaceutically-active agent within its approved dosage range. Sequential use is contemplated when a combination formulation is inappropriate.

In the field of medical oncology examples of such combinations include combinations with the following categories of therapeutic agent:

- 10 i) anti-angiogenic agents (for example linomide, inhibitors of integrin  $\alpha v \beta 3$  function, angiostatin, endostatin, razoxin, thalidomide) and including vascular endothelial growth factor (VEGF) receptor tyrosine kinase inhibitors (RTKIs) (for example those described in international patent applications publication nos. WO-97/22596, WO-97/30035, WO-97/32856 and WO-98/13354, the entire disclosure of which documents is incorporated  
15 herein by reference);
- ii) cytostatic agents such as anti-oestrogens (for example tamoxifen, toremifene, raloxifene, droloxifene, idoxyfene), progestogens (for example megestrol acetate), aromatase inhibitors (for example anastrozole, letrozole, vorazole, exemestane), anti-progestogens, anti-androgens (for example flutamide, nilutamide, bicalutamide, cyproterone  
20 acetate), inhibitors of testosterone  $5\alpha$ -dihydroreductase (for example finasteride), anti-invasion agents (for example metalloproteinase inhibitors like marimastat and inhibitors of urokinase plasminogen activator receptor function) and inhibitors of growth factor function, (such growth factors include for example epidermal growth factor (EGF), platelet derived growth factor and hepatocyte growth factor such inhibitors include growth factor antibodies,  
25 growth factor receptor antibodies, tyrosine kinase inhibitors and serine/threonine kinase inhibitors);
- iii) biological response modifiers (for example interferon);
- iv) antibodies (for example edrecolomab); and
- v) anti-proliferative/anti-neoplastic drugs and combinations thereof, as used  
30 in medical oncology, such as anti-metabolites (for example anti-folates like methotrexate, fluoropyrimidines like 5-fluorouracil, purine and adenosine analogues, cytosine arabinoside); anti-tumour antibiotics (for example anthracyclines like doxorubicin, daunomycin, epirubicin and idarubicin, mitomycin-C, dactinomycin, mithramycin); platinum derivatives (for example

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- cisplatin, carboplatin); alkylating agents (for example nitrogen mustard, melphalan, chlorambucil, busulphan, cyclophosphamide, ifosfamide, nitrosoureas, thiotepa); anti-mitotic agents (for example vinca alkaloids like vincristine and taxoids like taxol, taxotere); enzymes (for example asparaginase); thymidylate synthase inhibitors (for example raltitrexed);
- 5 topoisomerase inhibitors (for example epipodophyllotoxins like etoposide and teniposide, amsacrine, topotecan, irinotecan).

The compounds of the invention may also be used in combination with surgery or radiotherapy.

## 10 ASSAYS

The ability of compounds according to the invention to act as antagonists of GnRH can be determined using the following in vitro assays.

### Binding Assay Using Rat pituitary GnRH Receptor

The assay is performed as follows:-

- 15 1. Incubate crude plasma membranes prepared from rat pituitary tissues in a Tris.HCl buffer (pH. 7.5, 50 mM) containing bovine serum albumin (0.1%), [I-125]D-t-Bu-Ser6-Pro9-ethyl amide-GnRH, and the test compound. Incubation is at 4°C for 90 minutes to 2 hours.
2. Rapidly filter and repeatedly wash through a glass fibre filter.
- 20 3. Determine the radioactivity of membrane bound radio-ligands using a gamma counter.

From this data, the IC<sub>50</sub> of the test compound can be determined as the concentration of the compound required to inhibit radio-ligand binding to GnRH receptors by 50%.

Compounds according to the present invention have activity at a concentration from 1nM to 5 μM.

25

### Binding Assay Using Human GnRH Receptor

- Crude membranes prepared from CHO cells expressing human GnRH receptors are sources for the GnRH receptor. The binding activity of compounds according to the invention can be determined as an IC<sub>50</sub> which is the compound concentration required to inhibit the
- 30 specific binding of [<sup>125</sup>I]buserelin to GnRH receptors by 50%. [<sup>125</sup>I]Buserelin (a peptide GnRH analogue) is used here as a radiolabelled ligand of the receptor.

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Assay to Determine Inhibition of LH release

The LH release assay can be used to demonstrate antagonist activity of compounds, as demonstrated by a reduction in GnRH-induced LH release.

5 Preparation of Pituitary Glands

Pituitary glands obtained from rats are prepared as follows. Suitable rats are Wistar male rats (150-200g) which have been maintained at a constant temperature (eg, 25°C) on a 12 hour light/12 hour dark cycle. The rats are sacrificed by decapitation before the pituitary glands are aseptically removed to tube containing Hank's Balanced Salt Solution (HBSS).

10 The glands are further processed by:-

1. Centrifugation at 250 x g for 5 minutes;
2. Aspiration of the HBSS solution;
3. Transfer of the glands to a petri dish before mincing with a scalpel;
- 15 4. Transfer of the minced tissue to a centrifuge tube by suspending the tissue three successive times in 10 ml aliquots of HBSS containing 0.2% collagenase and 0.2% hyaluronidase;
5. Cell dispersion by gentle stirring of the tissue suspension while the tube is kept in a water bath at 37°C;
- 20 6. Aspiration 20 to 30 times using a pipette, undigested pituitary fragments being allowed to settle for 3 to 5 minutes;
7. Aspiration of the suspended cells followed by centrifugation at 1200 x g for 5 minutes;
8. Re-suspension of the cells in culture medium of DMEM containing 0.37% NaHCO<sub>3</sub>, 10% horse serum, 2.5% foetal bovine serum, 1% non essential amino acids, 1% glutamine and  
25 0.1% gentamycin;
9. Treatment of the undigested pituitary fragments 3 times with 30 ml aliquots of the collagenase and hyaluronidase;
10. Pooling of the cell suspensions and dilution to a concentration of  $3 \times 10^5$  cells/ml;
11. Placing of 1.0ml of this suspension in each of a 24 well tray, with the cells being  
30 maintained in a humidified 5% CO<sub>2</sub>/95% air atmosphere at 37°C for 3 to 4 days

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Testing of Compounds

The test compound is dissolved in DMSO to a final concentration of 0.5% in the incubation medium.

1.5 hours prior to the assay, the cells are washed three times with DMEM containing  
5 0.37% NaHCO<sub>3</sub>, 10% horse serum, 2.5% foetal bovine serum, 1% non essential amino acids (100X), 1% glutamine (100X), 1% penicillin/streptomycin (10,000 units of each per ml) and 25 mM HEPES at pH 7.4. Immediately prior to the assay, the cells are again washed twice in this medium .

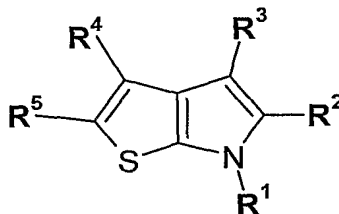
Following this, 1ml of fresh medium containing the test compound and 2nM GnRH is  
10 added to two wells. For other test compounds (where it is desired to test more than one compound), these are added to other respective duplicate wells. Incubation is then carried out at 37°C for three hours.

Following incubation, each well is analysed by removing the medium from the well and centrifuging the medium at 2000 x g for 15 minutes to remove any cellular material. The  
15 supernatant is removed and assayed for LH content using a double antibody radio-immuno assay. Comparison with a suitable control (no test compound) is used to determine whether the test compound reduces LH release. Compounds according to the present invention have activity at a concentration from 1nM to 5 µM.



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Claims

1. A compound of Formula (I),



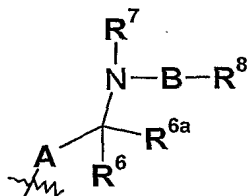
Formula (I)

wherein:

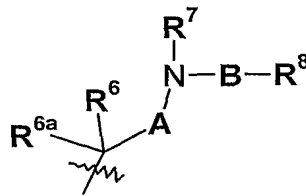
$R^1$  is selected from: hydrogen, optionally substituted  $C_{1-6}$ alkyl, optionally substituted aryl or optionally substituted aryl $C_{1-6}$ alkyl, wherein the optional substituents are selected from  $C_{1-4}$ alkyl,  $C_{1-4}$ alkoxy, nitro, cyano and fluoro;

$R^2$  is hydrogen, optionally substituted  $C_{1-6}$ alkyl or an optionally substituted mono or bi-cyclic aromatic ring, wherein the optional substituents are 1, 2 or 3 substituents independently selected from: cyano,  $R^e R^f N$ -,  $C_{1-6}$ alkyl,  $C_{1-6}$ alkoxy, halo, halo $C_{1-6}$ alkyl or halo $C_{1-6}$ alkoxy wherein  $R^e$  and  $R^f$  are independently selected from hydrogen,  $C_{1-6}$ alkyl or aryl;

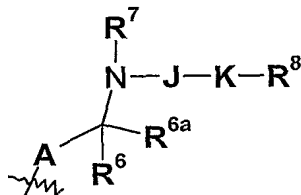
$R^3$  is selected from a group of Formula (IIa) to Formula (IId):



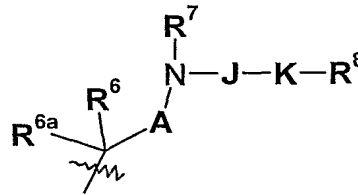
Formula (IIa)



Formula (IIb)



Formula (IIc)

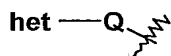


Formula (IIId)

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$R^4$  is selected from hydrogen,  $C_{1-4}$ alkyl or halo;

$R^5$  is a group of the formula



wherein:

- 5        **het** represents a heteroaryl ring, optionally substituted by from 1 to 2 groups selected from  $R^{12}$  and  $R^{13}$ ; and

**Q** is selected from a direct bond or  $-[C(R^{15}R^{15a})]_{1-2}-$

each  $R^{15}$  and  $R^{15a}$  are independently selected from:

- 10        (i) hydrogen or optionally substituted  $C_{1-8}$ alkyl, wherein the optional substituents are selected from  $R^{12}$ ; or
- (ii)  $R^{15}$  and  $R^{15a}$  together with the carbon to which they are attached form an optionally substituted 3 to 7-membered cycloalkyl ring, wherein the optional substituents are selected from  $R^{12}$ ;

- 15         $R^6$  and  $R^{6a}$  are independently selected from hydrogen, fluoro, optionally substituted  $C_{1-6}$ alkyl,  $C_{1-6}$ alkoxy,  $N$ - $C_{1-6}$ alkylamino and  $N,N$ -di $C_{1-6}$ alkylamino or  $R^6$  and  $R^{6a}$  taken together and the carbon atom to which they are attached form a carbocyclic ring of 3-7 atoms or  $R^6$  and  $R^{6a}$  taken together and the carbon atom to which they are attached form a carbonyl group;

- 20        or when **A** is not a direct bond the group forms a carbocyclic ring of 3-7 carbon atoms or a heterocyclic ring containing one or more heteroatoms;

- or the group forms a heterocyclic ring containing 3-7 carbon atoms and one or more heteroatoms;

$R^7$  is selected from: hydrogen or  $C_{1-6}$ alkyl;

$R^8$  is selected from:

- 25        (i) hydrogen,  $C_{1-6}$ alkyl,  $C_{2-6}$ alkenyl,  $C_{2-6}$ alkynyl, halo $C_{1-6}$ alkyl,  $C_{1-4}$ alkoxy $C_{1-4}$ alkyl, hydroxy, hydroxy $C_{1-6}$ alkyl, cyano,  $N$ - $C_{1-4}$ alkylamino,  $N,N$ -di- $C_{1-4}$ alkylamino,  $C_{1-6}$ alkyl- $S(O_n)-$ ,  $-O-R^b$ ,  $-NR^bR^c$ ,  $-C(O)-R^b$ ,  $-C(O)O-R^b$ ,  $-CONR^bR^c$ ,  $NH-C(O)-R^b$  or  $-$

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$$S(O_n)NR^bR^c,$$

where  $R^b$  and  $R^c$  are independently selected from hydrogen and  $C_{1-6}$ alkyl (e.g.  $C_{1-4}$ alkyl) optionally substituted with hydroxy, amino,  $N$ - $C_{1-4}$ alkylamino,  $N,N$ -di- $C_{1-4}$ alkylamino,  $HO$ - $C_{2-4}$ alkyl-NH- or  $HO$ - $C_{2-4}$ alkyl- $N$ ( $C_{1-4}$ alkyl)-;

- 5 (ii) nitro when  $B$  is a group of Formula (IV) and  $X$  is CH and  $p$  is 0;  
 (iii) carbocyclyl (such as  $C_{3-7}$ cycloalkyl or aryl) or aryl $C_{1-6}$ alkyl each of which is optionally substituted by  $R^{12}$  or  $R^{13}$ ;  
 (iv) heterocyclyl or heterocyclyl $C_{1-6}$ alkyl each of which is optionally substituted by up to 4 substituents independently selected from  $R^{12}$  or  $R^{13}$  and where any nitrogen atoms  
 10 within a heterocyclyl group are, where chemically allowed, optionally in their oxidised ( $N \rightarrow O$ ,  $N-OH$ ) state;

$R^{12}$  is independently selected from: halo, hydroxy, hydroxy $C_{1-6}$ alkyl, oxo, cyano,

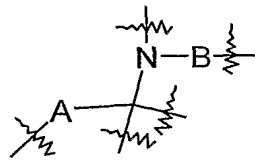
- cyano $C_{1-6}$ alkyl, nitro, carboxyl,  $C_{1-6}$ alkyl,  $C_{1-6}$ alkoxy,  $C_{1-6}$ alkoxy $C_{1-4}$ alkyl,  
 $C_{1-6}$ alkoxycarbonyl $C_{0-4}$ alkyl,  $C_{1-6}$ alkanoyl $C_{0-4}$ alkyl,  $C_{1-6}$ alkanoyloxy $C_{0-4}$ alkyl,  
 15  $C_{2-6}$ alkenyl,  $C_{1-3}$ perfluoroalkyl-,  $C_{1-3}$ perfluoroalkoxy, aryl, aryl $C_{1-6}$ alkyl, heterocyclyl, heterocyclyl $C_{1-6}$ alkyl, amino $C_{0-4}$ alkyl,  $N$ - $C_{1-4}$ alkylamino $C_{0-4}$ alkyl,  $N$ ,  $N$ -di- $C_{1-4}$ alkylamino $C_{0-4}$ alkyl, carbamoyl,  $N$ - $C_{1-4}$ alkylcarbamoyl $C_{0-2}$ alkyl,  $N$ ,  $N$ -di- $C_{1-4}$ alkylaminocarbamoyl $C_{0-2}$ alkyl, aminocarbonyl $C_{0-4}$ alkyl,  $N$ - $C_{1-6}$ alkylaminocarbonyl $C_{1-4}$ alkyl,  $N$ ,  $N$ - $C_{1-6}$ alkylaminocarbonyl $C_{0-4}$ alkyl,  
 20  $C_{1-6}$ alkyl- $S(O)_n$ -amino $C_{0-4}$ alkyl-, aryl- $S(O)_n$ -amino $C_{0-2}$ alkyl-,  $C_{1-3}$ perfluoroalkyl- $S(O)_n$ -amino $C_{0-2}$ alkyl-;  $C_{1-6}$ alkylamino- $S(O)_n$ - $C_{0-2}$ alkyl-, arylamino- $S(O)_n$ - $C_{0-2}$ alkyl-,  $C_{1-3}$ perfluoroalkylamino- $S(O)_n$ - $C_{0-2}$ alkyl-,  $C_{1-6}$ alkanoylamino- $S(O)_n$ - $C_{0-2}$ alkyl-; arylcarbonylamino- $S(O)_n$ - $C_{0-2}$ alkyl-,  $C_{1-6}$ alkyl- $S(O)_n$ - $C_{0-2}$ alkyl-, aryl- $S(O)_n$ - $C_{0-2}$ alkyl-,  $C_{1-3}$ perfluoroalkyl-,  
 25  $C_{1-3}$ perfluoroalkoxy $C_{0-2}$ alkyl;  $R^9OC(O)(CH_2)_w$ -,  $R^9R^{10}N(CH_2)_w$ -,  $R^9R^{10}NC(O)(CH_2)_w$ -,  $R^9R^{10}NC(O)N(R^9)(CH_2)_w$ -,  $R^9OC(O)N(R^9)(CH_2)_w$ -, or halo, wherein  $w$  is an integer between 0 and 4 and  $R^9$  and  $R^{10}$  are independently selected from hydrogen,  $C_{1-4}$ alkyl,  $C_{1-4}$ alkylsulphonyl and  $C_{3-7}$ carbocyclyl,  $R^9$  and  $R^{10}$  are independently selected from  $C_{1-4}$ alkylsulphonyl and  $C_{3-7}$ carbocyclyl, and  $R^9$  and  $R^{10}$  are  $C_{3-7}$ carbocyclyl; wherein an amino or an aryl group within  $R^{12}$  is optionally substituted by  $C_{1-4}$ alkyl;
- 30

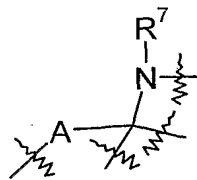
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$R^{13}$  is  $C_{1-4}$ alkylaminocarbonyl optionally substituted by 1, 2 or 3 groups selected from  $R^{12}$ , or  $R^{13}$  is a group  $-C(O)-R^{16}$  where  $R^{16}$  is selected from an amino acid derivative or an amide of an amino acid derivative;

A is selected from:

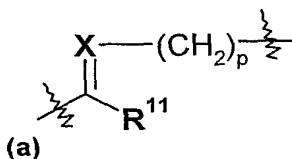
- 5 (i) a direct bond;
- (ii) optionally substituted  $C_{1-5}$ alkylene wherein the optional substituents are independently selected from: hydroxy, hydroxy $C_{1-6}$ alkyl,  $C_{1-6}$ alkyl,  $C_{1-6}$ alkoxy,  $C_{1-4}$ alkoxy $C_{1-4}$ alkyl, aryl or aryl $C_{1-6}$ alkyl;
- (iii) a carbocyclic ring of 3-7 atoms;
- 10 (iv) a carbonyl group or  $-C(O)-C(R^dR^d)-$ , wherein  $R^d$  is independently selected from hydrogen and  $C_{1-2}$ alkyl;

or when  $R^3$  is a group of Formula (IIa) or (IIb), the group  forms a heterocyclic ring containing 3-7 carbon atoms and one or more heteroatoms;

or when  $R^3$  is a group of Formula (IIa), (IIb), (IIc) or (IId), the group  forms a heterocyclic ring containing 3-7 carbon atoms and one or more heteroatoms;

B is selected from:

- (i) a direct bond;
- (ii) a group of Formula (IV)



Formula (IV)

wherein:

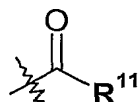
X is selected from N or CH,

wherein at position (a) Formula (IV) is attached to the nitrogen atom and the  $(CH_2)_p$  group is attached to  $R^8$ ; and

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(iii) a group independently selected from: optionally substituted C<sub>1-6</sub>alkylene, optionally substituted C<sub>3-7</sub>cycloalkyl, optionally substituted C<sub>3-6</sub>alkenylene, optionally substituted C<sub>3-6</sub>alkynyl, (C<sub>1-5</sub>alkyl)<sub>aa</sub>-S(O<sub>n</sub>)-(C<sub>1-5</sub>alkyl)<sub>bb</sub>-, -(C<sub>1-5</sub>alkyl)<sub>aa</sub>-O-(C<sub>1-5</sub>alkyl)<sub>bb</sub>-, -(C<sub>1-5</sub>alkyl)<sub>aa</sub>-C(O)-(C<sub>1-5</sub>alkyl)<sub>bb</sub>- or (C<sub>1-5</sub>alkyl)<sub>aa</sub>-N(R<sup>14</sup>)-(C<sub>1-5</sub>alkyl)<sub>bb</sub>, or (C<sub>1-5</sub>alkyl)<sub>aa</sub>-C(O)N(R<sup>14</sup>)-(C<sub>1-5</sub>alkyl)<sub>bb</sub>, wherein R<sup>14</sup> is hydrogen or C<sub>1-4</sub>alkyl, or R<sup>14</sup> and the (C<sub>1-5</sub>alkyl)<sub>aa</sub> or (C<sub>1-5</sub>alkyl)<sub>bb</sub> chain can be joined to form a heterocyclic ring, wherein aa and bb are independently 0 or 1, and the combined length of (C<sub>1-5</sub>alkyl)<sub>aa</sub> and (C<sub>1-5</sub>alkyl)<sub>bb</sub> is less than or equal to C<sub>5</sub>alkyl and wherein the optional substituents are independently selected from R<sup>12</sup>;

or the group -B-R<sup>8</sup> represents a group of Formula (V)



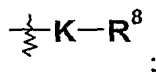
Formula (V);

or the group together forms an optionally substituted heterocyclic ring containing 4-7 carbons atoms, wherein the optional substituents are selected from 1 or 2 substituents independently selected from R<sup>12</sup> and R<sup>13</sup>;

or the group forms a heterocyclic ring containing 3-7 carbon atoms and one or more heteroatoms;

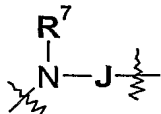
R<sup>11</sup> is selected from: hydrogen, optionally substituted C<sub>1-6</sub>alkyl or N(R<sup>23</sup>R<sup>24</sup>);

R<sup>23</sup> and R<sup>24</sup> are independently selected from: hydrogen, hydroxy, optionally substituted C<sub>1-6</sub>alkyl, optionally substituted aryl, optionally substituted arylC<sub>1-6</sub>alkyl, an optionally substituted carbocyclic ring of 3-7 atoms, optionally substituted heterocyclyl, optionally substituted heterocyclylC<sub>1-6</sub>alkyl or R<sup>23</sup> and R<sup>24</sup> taken together can form an optionally substituted ring of 3-9 atoms, wherein the optional substituents are selected from R<sup>12</sup> and



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**J** is a group of the formula:  $-(CH_2)_s-L-(CH_2)_s-$  or  $-(CH_2)_s-C(O)-(CH_2)_s-L-(CH_2)_s-$  wherein when *s* is greater than 0, the alkylene group is optionally substituted by 1 or 2 groups selected from **R**<sup>12</sup>,



or the group together forms an optionally substituted heterocyclic ring

5 containing 4-7 carbons atoms, wherein the optional substituents are selected from 1 or 2 substituents independently selected from **R**<sup>12</sup> and **R**<sup>13</sup>;

**K** is selected from: a direct bond,  $-(CR^{21}R^{22})_{s1}-$ ,  $-(CR^{21}R^{22})_{s1}-O-(CR^{21}R^{22})_{s2}-$ ,

$-(CR^{21}R^{22})_{s1}-C(O)-(CR^{21}R^{22})_{s2}-$ ,  $-(CR^{21}R^{22})_{s1}-S(O)_n-(CR^{21}R^{22})_{s2}-$ ,

$-(CR^{21}R^{22})_{s1}-N(R^{14a})-(CR^{21}R^{22})_{s2}-$ ,  $-(CR^{21}R^{22})_{s1}-C(O)N(R^{14a})-(CR^{21}R^{22})_{s2}-$ ,

10  $-(CR^{21}R^{22})_{s1}-N(R^{14a})C(O)-(CR^{21}R^{22})_{s2}-$ ,  $-(CR^{21}R^{22})_{s1}-N(R^{14a})C(O)N(R^{14a})-(CR^{21}R^{22})_{s2}-$ ,

$-(CR^{21}R^{22})_{s1}-OC(O)-(CR^{21}R^{22})_{s2}-$ ,  $-(CR^{21}R^{22})_{s1}-C(O)O-(CR^{21}R^{22})_{s2}-$ ,

$-(CR^{21}R^{22})_{s1}-N(R^{14a})C(O)O-(CR^{21}R^{22})_{s2}-$ ,  $-(CR^{21}R^{22})_{s1}-OC(O)N(R^{14a})-(CR^{21}R^{22})_{s2}-$ ,

$-(CR^{21}R^{22})_{s1}-OS(O)_n-(CR^{21}R^{22})_{s2}$ , or  $-(CR^{21}R^{22})_{s1}-S(O)_n-O-(CR^{21}R^{22})_{s2}-$ ,

$-(CR^{21}R^{22})_{s1}-S(O)_2N(R^{14a})-(CR^{21}R^{22})_{s2}$  or  $-(CR^{21}R^{22})_{s1}-N(R^{14a})S(O)_2-(CR^{21}R^{22})_{s2}-$ ;

15 wherein **R**<sup>14a</sup> is hydrogen or C<sub>1-4</sub>alkyl, each **R**<sup>21</sup> and **R**<sup>22</sup> group is independently selected from hydrogen, hydroxy or optionally substituted C<sub>1-4</sub>alkyl, wherein the optional substituent is a group **ZR**<sup>30</sup> where **Z** is oxygen or a group **S(O)<sub>n</sub>**, and **R**<sup>30</sup> is hydrogen or C<sub>1-4</sub>alkyl;

**L** is selected from optionally substituted aryl or optionally substituted heterocyclyl;

20 **n** is an integer from 0 to 2;

**p** is an integer from 0 to 4;

**s**, **s1** and **s2** are independently selected from an integer from 0 to 4, and

**s1+s2** is less than or equal to 4;

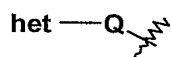
or a salt, solvate or pro-drug thereof.

25

2. A compound according to claim 1 which contains a group **R**<sup>13</sup> which is  $-C(O)-R^{16}$ , where **R**<sup>16</sup> is selected from an amino acid derivative or an amide of an amino acid derivative; or a salt, solvate or pro-drug thereof.

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3. A compound according to claim 1 or claim 2 wherein  $R^1$  is selected from hydrogen, optionally substituted  $C_{1-6}$ alkyl or optionally substituted aryl $C_{1-6}$ alkyl, wherein the optional substituents are selected from: fluoro and  $C_{1-4}$ alkoxy.
- 5 4. A compound according to any one of the preceding claims wherein  $R^2$  is phenyl, optionally substituted by one or more groups selected from methyl, ethyl, methoxy, ethoxy, *tert*-butoxy, F or Cl.
5. A compound according to any one of the preceding claims wherein  $R^3$  is selected from  
10 a group of formula (IIc) or formula (IId).
6. A compound according to any one of the preceding claims wherein  $R^4$  is selected from hydrogen, methyl, ethyl, chloro or bromo.
- 15 7. A compound according to any one of the preceding claims wherein  $R^5$  is a group of the formula



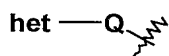
wherein:

- 20 **het** represents a heteroaryl ring, optionally substituted by from 1 to 2 groups selected from  $R^{12}$  and  $R^{13}$  as defined in claim 1; and  
**Q** is selected from a direct bond or  $-\text{C}(\text{R}^{15}\text{R}^{15a})-$ , where  $R^{15}$  and  $R^{15a}$  are as defined in claim 1.

8. A compound according to any one of the preceding claims wherein **het** in the group  $R^5$   
 25 is oxadiazolyl, thienyl, furanyl, thiazolyl, thiadiazolyl, triazolyl, pyrazolyl, imidazolyl, oxazolyl, isoxazolyl, pyridyl, pyrazinyl, pyridazinyl or pyrimidinyl
9. A compound according to any one of the preceding claims wherein the group **het** in the group  $R^5$  is substituted by hydroxy, hydroxy $C_{1-8}$ alkyl,  $C_{1-8}$ alkyl,  $C_{1-8}$ alkoxy,  
 30  $C_{1-4}$ alkoxy $C_{1-4}$ alkyl or phenyl optionally substituted by  $C_{1-4}$ alkyl.

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3. A compound according to claim 1 or claim 2 wherein  $R^1$  is selected from hydrogen, optionally substituted  $C_{1-6}$ alkyl or optionally substituted aryl $C_{1-6}$ alkyl, wherein the optional substituents are selected from: fluoro and  $C_{1-4}$ alkoxy.
- 5 4. A compound according to any one of the preceding claims wherein  $R^2$  is phenyl, optionally substituted by one or more groups selected from methyl, ethyl, methoxy, ethoxy, *tert*-butoxy, F or Cl.
5. A compound according to any one of the preceding claims wherein  $R^3$  is selected from  
10 a group of formula (IIc) or formula (IId).
6. A compound according to any one of the preceding claims wherein  $R^4$  is selected from hydrogen, methyl, ethyl, chloro or bromo.
- 15 7. A compound according to any one of the preceding claims wherein  $R^5$  is a group of the formula



wherein:

- 20 **het** represents a heteroaryl ring, optionally substituted by from 1 to 2 groups selected from  $R^{12}$  and  $R^{13}$  as defined in claim 1; and  
**Q** is selected from a direct bond or  $-\text{C}(\text{R}^{15}\text{R}^{15a})-$ , where  $R^{15}$  and  $R^{15a}$  are as defined in claim 1.

8. A compound according to any one of the preceding claims wherein **het** in the group  $R^5$   
 25 is oxadiazolyl, thienyl, furanyl, thiazolyl, thiadiazolyl, triazolyl, pyrazolyl, imidazolyl, oxazolyl, isoxazolyl, pyridyl, pyrazinyl, pyridazinyl or pyrimidinyl
9. A compound according to any one of the preceding claims wherein the group **het** in the group  $R^5$  is substituted by hydroxy, hydroxy $C_{1-8}$ alkyl,  $C_{1-8}$ alkyl,  $C_{1-8}$ alkoxy,  
 30  $C_{1-4}$ alkoxy $C_{1-4}$ alkyl or phenyl optionally substituted by  $C_{1-4}$ alkyl.



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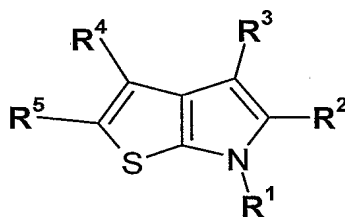
10. A compound according to any one of the preceding claims wherein  $R^{15}$  and  $R^{15a}$  are selected from hydrogen and methyl.

11. A compound according to any one of the preceding claims wherein  $R^6$  and  $R^{6a}$  independently selected from hydrogen, unsubstituted  $C_{1-6}$ alkyl or  $R^6$  and  $R^{6a}$  taken together and the carbon atom to which they are attached form a carbocyclic ring of 3-7 atoms.

12. A compound according to any one of the preceding claims wherein  $R^8$  is selected from optionally substituted  $C_{4-7}$ heterocyclyl selected from piperidinyl or piperazinyl, azetidiny, imidazolyl and thiazolyl, wherein the optional substituents are selected from  $R^{12}$  and  $R^{13}$  as defined in claim 1.

13. A compound according to any one of the preceding claims wherein A is a direct bond or methylene.

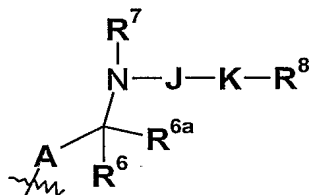
14. A compound according to claim 1 of formula (Ic)



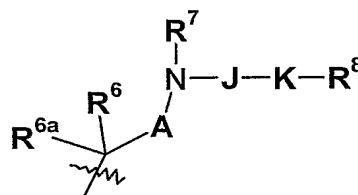
Formula (Ic)

wherein:

20  $R^3$  is selected from a group of Formula (IIc) or Formula (IId):



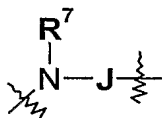
Formula (IIc)



Formula (IId)

wherein

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the group together forms an optionally substituted heterocyclic ring containing 4-7 carbons atoms, wherein the optional substituents are selected from 1 or 2 substituents independently selected from  $R^{12}$  and  $R^{13}$ ;

and A, J,  $R^1$ ,  $R^2$ ,  $R^4$ ,  $R^5$ ,  $R^6$ ,  $R^{6a}$ ,  $R^8$ , and  $R^{12}$  and  $R^{13}$  are as defined in claim 1,

5 or a salt, solvate or pro-drug thereof.

15. A compound according to claim 14 wherein:

K is  $-(CH_2)_{s1}-C(O)-(CH_2)_{s2}-$  or  $-(CH_2)_{s1}-$ ;

$R^8$  is selected from:  $C_{3-7}$ cycloalkyl, aryl or heterocyclyl each of which is optionally substituted by one or substituents independently selected from  $R^{12}$  or  $R^{13}$ ; and

s1 and s2 are as defined above;

or a salt, solvate or pro-drug thereof.

16. A compound according to claim 1 which is selected from:

15 2-[1-(5-butyl-1,3,4-oxadiazol-2-yl)-1-methylethyl]-5-(3,5-dimethylphenyl)-4-{2-[4-(2-oxo-2-pyrrolidin-1-ylethyl)piperazin-1-yl]ethyl}-6H-thieno[2,3-b]pyrrole;  
 5-(3,5-dimethylphenyl)-2-[1-methyl-1-(5-propyl-1,3,4-oxadiazol-2-yl)ethyl]-4-{2-[4-(2-oxo-2-pyrrolidin-1-ylethyl)piperazin-1-yl]ethyl}-6H-thieno[2,3-b]pyrrole;  
 5-(3,5-dimethylphenyl)-2-[1-(5-ethyl-1,3,4-oxadiazol-2-yl)-1-methylethyl]-4-{2-[4-(2-oxo-2-pyrrolidin-1-ylethyl)piperazin-1-yl]ethyl}-6H-thieno[2,3-b]pyrrole; and  
 20 5-(3,5-dimethylphenyl)-2-[1-methyl-1-(5-methyl-1,3,4-oxadiazol-2-yl)ethyl]-4-{2-[4-(2-oxo-2-pyrrolidin-1-ylethyl)piperazin-1-yl]ethyl}-6H-thieno[2,3-b]pyrrole;  
 5-(3,5-dimethylphenyl)-2-[1-methyl-1-(5-phenyl-1,3,4-oxadiazol-2-yl)ethyl]-4-{2-[4-(2-oxo-2-pyrrolidin-1-ylethyl)piperazin-1-yl]ethyl}-6H-thieno[2,3-b]pyrrole  
 25 5-(3,5-dimethylphenyl)-2-[1-methyl-1-(5-methyl-4H-1,2,4-triazol-3-yl)ethyl]-4-{2-[4-(2-oxo-2-pyrrolidin-1-ylethyl)piperazin-1-yl]ethyl}-6H-thieno[2,3-b]pyrrole  
 5-(3,5-dimethylphenyl)-2-{1-methyl-1-[3-(4-methylphenyl)-1,2,4-oxadiazol-5-yl]ethyl}-4-{2-[4-(2-oxo-2-pyrrolidin-1-ylethyl)piperazin-1-yl]ethyl}-6H-thieno[2,3-b]pyrrole  
 (3S)-1-{[1-(2-{5-(3,5-dimethylphenyl)-2-[1-(5-ethyl-1,3,4-oxadiazol-2-yl)-1-methylethyl]-  
 30 6H-thieno[2,3-b]pyrrol-4-yl]ethyl)piperidin-4-yl]carbonyl}piperidin-3-ol

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5-(3,5-dimethylphenyl)-2-[1-(5-ethyl-1,3,4-oxadiazol-2-yl)-1-methylethyl]-4-{2-[4-(morpholin-4-ylcarbonyl)piperidin-1-yl]ethyl}-6*H*-thieno[2,3-*b*]pyrrole

5-(3,5-dimethylphenyl)-2-[1-(3-isopropyl-1*H*-1,2,4-triazol-5-yl)-1-methylethyl]-4-{2-[4-(morpholin-4-ylcarbonyl)piperidin-1-yl]ethyl}-6*H*-thieno[2,3-*b*]pyrrole

5 or a salt, pro-drug or solvate thereof.

17. A pharmaceutical formulation comprising a compound according to any one of the preceding claims, or salt, pro-drug or solvate thereof, and a pharmaceutically acceptable diluent or carrier.

10

18. A method of antagonising gonadotropin releasing hormone activity in a patient, comprising administering a compound according to any one of claims 1 to 16, or salt, pro-drug or solvate thereof, to a patient.

15 19. A compound according to any one of claims 1 to 16 for use as a medicament.

20. The use of a compound according to any one of claims 1 to 16, or a salt, solvate or pro-drug thereof, in the manufacture of a medicament for

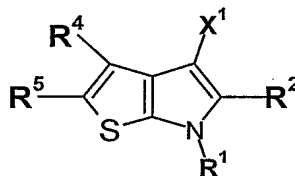
(a) antagonising gonadotropin releasing hormone activity;

20 (b) administration to a patient, for reducing the secretion of luteinizing hormone by the pituitary gland of the patient; and

(c) administration to a patient, for therapeutically treating and/or preventing a sex hormone related condition in the patient.

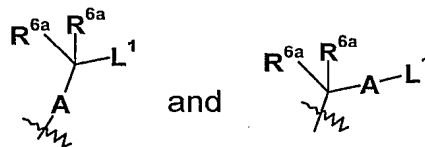
25 21. A process for preparing a compound according to any one of claims 1 to 16, which process comprises reaction selected from the

(a) reaction of a compound of formula **XXXII** with a compound of formula  $H-R^{3'}$



XXXII

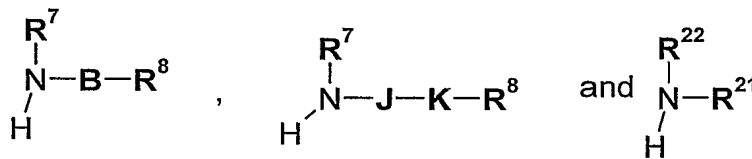
- 82 -



wherein  $R^1$ ,  $R^2$ ,  $R^4$ ,  $R^5$  and  $X^1$  is selected from:

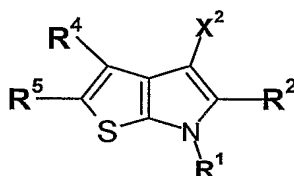
;  $L^1$  is a

displaceable group;

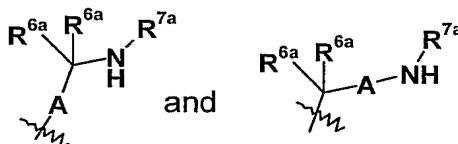


$H-R^3$  is selected from:

(b) reaction of a compound of formula XXXIII with a compound of formula  $L^2-R^{3''}$ ,



XXXIII



wherein  $X^2$  is selected from:

;  $L^2$  is a displaceable

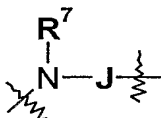
group and  $R^{7a}$  is selected from the definition of  $R^7$  or  $R^{22}$  above, and

$L^2-R^{3''}$  is selected from:  $L^2-B-R^8$ ,  $L^2-J-K-R^8$  and  $L^2-R^{21}$ ;

(c) for compounds of Formula (I) wherein  $R^7$  is other than part of a heterocyclic ring or

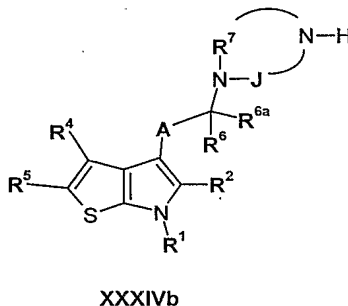
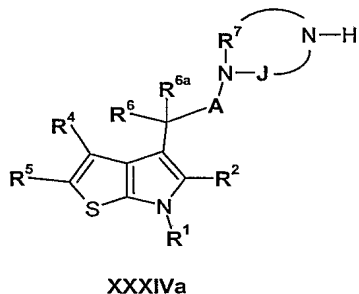
hydrogen, reaction of a compound of Formula (I) wherein  $R^7$  is hydrogen with a group of formula  $L^3-R^{7a}$ , wherein  $R^{7a}$  is as defined above for  $R^7$  with the exclusion of hydrogen and  $L^3$  is a displaceable group;

(d) for compounds of Formula (I) wherein  $R^3$  is a group of Formula (IIc) or (IId) and

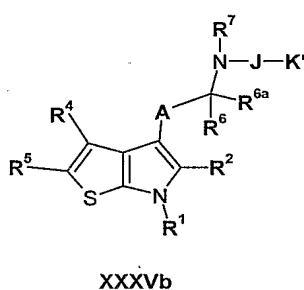
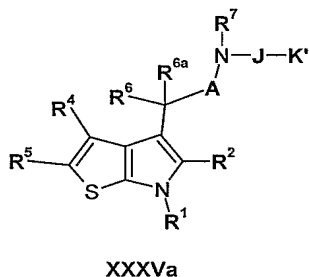


the group together forms an optionally substituted nitrogen-containing heterocyclic ring containing 4-7 carbons atoms, reaction of a compound of Formula XXXIVa or XXXIVb, with a compound of Formula  $L^6-K-R^8$ , wherein  $L^6$  is a displaceable group

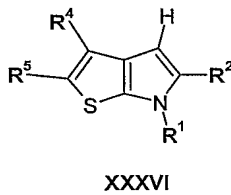
- 83 -



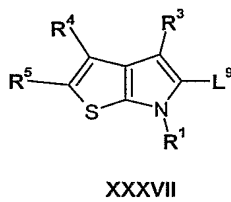
- (e) for compounds of Formula (I) wherein  $R^3$  is a group of Formula (IIc) or (IId), reaction of a compound of Formula XXXVa or XXXVb, with a compound of Formula  $L^7-K''-R^8$ , wherein  $L^7$  is a displaceable group, and wherein the groups  $K'$  and  $K''$  comprise groups which when reacted together form  $K$ ,



- (f) reaction of a compound of Formula XXXVI with an electrophilic compound of the formula  $L^8-R^3$ , wherein  $L^8$  is a displaceable group.



- 10 (g) reaction of a compound of Formula XXXVII with a compound of the formula  $L^{10}-R^2$ , wherein  $L^9$  is a leaving group and  $L^{10}$  is an activating group or  $L^9$  is an activating group and  $L^{10}$  is a leaving group



and thereafter if necessary:

- 15 i) converting a compound of the Formula (I) into another compound of the Formula (I);  
 ii) removing any protecting groups;  
 iii) forming a salt, pro-drug or solvate.

# INTERNATIONAL SEARCH REPORT

PCT/GB2005/000598

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 C07D495/04

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C07D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, CHEM ABS Data, BEILSTEIN Data, PAJ, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	WO 2004/018479 A (ASTRAZENECA AB; ASTRAZENECA UK LIMITED; ARNOULD, JEAN, CLAUDE) 4 March 2004 (2004-03-04) cited in the application page 1, line 2 - line 32 page 2, Formula (I) Examples page 58, line 20 - line 31 -----	1-21
P,X	WO 2004/018480 A (ASTRAZENECA AB; ASTRAZENECA UK LIMITED; FOOTE, KEVIN, MICHAEL; MATUSIA) 4 March 2004 (2004-03-04) cited in the application page 1, line 2 - line 22 page 2, Formula (I) Examples page 192, line 26 - page 193, line 1 ----- -/--	1-21



Further documents are listed in the continuation of box C.



Patent family members are listed in annex

° Special categories of cited documents :

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- \*&\* document member of the same patent family

Date of the actual completion of the international search

2 August 2005

Date of mailing of the international search report

16/08/2005

Name and mailing address of the ISA

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Authorized officer

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## INTERNATIONAL SEARCH REPORT

PCT/GB2005/000598

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 02/066477 A (ASTRAZENECA AB; ASTRAZENECA UK LIMITED; DOSSETTER, ALEXANDER, GRAHAM;) 29 August 2002 (2002-08-29) cited in the application page 1, line 3 - page 2, line 5 page 2, Formula I Examples page 76, line 12 - line 20 -----	1-21
A	WO 02/092565 A (ASTRAZENECA AB; ASTRAZENECA UK LIMITED; WARDLEWORTH, JAMES, MICHAEL; D) 21 November 2002 (2002-11-21) cited in the application page 1, line 3 - line 33 page 2, Formula I Examples page 47, line 6 - line 17 -----	1-21

# INTERNATIONAL SEARCH REPORT

PCT/GB2005/000598

## Box II Observations where certain claims were found unsearchable (Continuation of Item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☒ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:  
  
Although claim 18 is directed to a method of treatment of the human/animal body, the search has been carried out and based on the alleged effects of the compound/composition.
2. ☐ Claims Nos.:  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

### Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.



# INTERNATIONAL SEARCH REPORT

PCT/GB2005/000598

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2004018479 A	04-03-2004	AU 2003267551 A1 EP 1532154 A1 WO 2004018479 A1	11-03-2004 25-05-2005 04-03-2004
WO 2004018480 A	04-03-2004	AU 2003255818 A1 EP 1543012 A1 WO 2004018480 A1	11-03-2004 22-06-2005 04-03-2004
WO 02066477 A	29-08-2002	WO 02066477 A2	29-08-2002
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